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Resource Management and Protection Plan

Wachusett Mountain State Reservation

Princeton/Westminster, Massachusetts

June 1999

GOVERNMENT DOCUMENTS
COLLECTION

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University of Massachusett
Depository Copy

Prepared for:

Commonwealth of Massachusetts
Department of Environmental Management
100 Cambridge Street
Boston, MA 02202

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Resource Management and Protection Plan

Wachusett Mountain State Reservation

Princeton/Westminster, Massachusetts

Prepared for:

Commonwealth of Massachusetts
Department of Environmental Management
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SECTION 1.0

Introduction

1.0 INTRODUCTION

Wachusett Mountain State Reservation (WMSR) provides 2025± acres of public open space, including Wachusett Mountain itself, the highest point of land in eastern and central Massachusetts (elevation 2006 feet). Figure 1-1 is a reproduction of the USGS map coverage of WMSR, highlighting the boundaries of the Reservation. WMSR is predominately forested, and includes the largest known stand of old growth forest in Massachusetts, among several other natural communities.[1] In addition, from a cultural resource standpoint, the mountain has played an important role in Native American history, and contains vestiges of historical Euro-American settlement as evidenced by stone walls throughout the Reservation and survey markings on the summit.

In large part due to the array of its natural and cultural resources, the Reservation is a very popular destination for a variety of outdoor recreational opportunities, from passive activities such as 'leaf-peeping' and bird-watching, to active pursuits such as hiking, sightseeing, downhill skiing and snow-boarding. These activities draw visitors not only from Massachusetts, but from neighboring states and foreign countries as well. As a tourist destination, economic revenues are generated by visitors to WMSR, who may utilize overnight accommodations, food services, and various 'spin-off' businesses, from gasoline sales to locally produced agricultural and manufactured goods.

The Department of Environmental Management (DEM) serves as steward to Wachusett Mountain State Reservation, and in this capacity has developed the present Resource Management and Protection Plan (RMPP) to establish guidance for day-to-day operation of the Reservation. This document is in part an update of a plan developed in 1985 entitled "Guidelines for Operations and Land Stewardship" (the GOALS plan). However, the present RMPP seeks to move beyond reporting on the status of the GOALS plan to address contemporary concerns regarding the management of the Reservation in light of increased year-round visitation and DEM's broader understanding of natural and cultural resources within the Reservation.

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[1] Foster, D.R., D.A. Orwig, and J.F. O'Keefe. 1996. Final Report on Old Growth Forests on Wachusett Mountain. Report commissioned by the Massachusetts Department of Environmental Management.

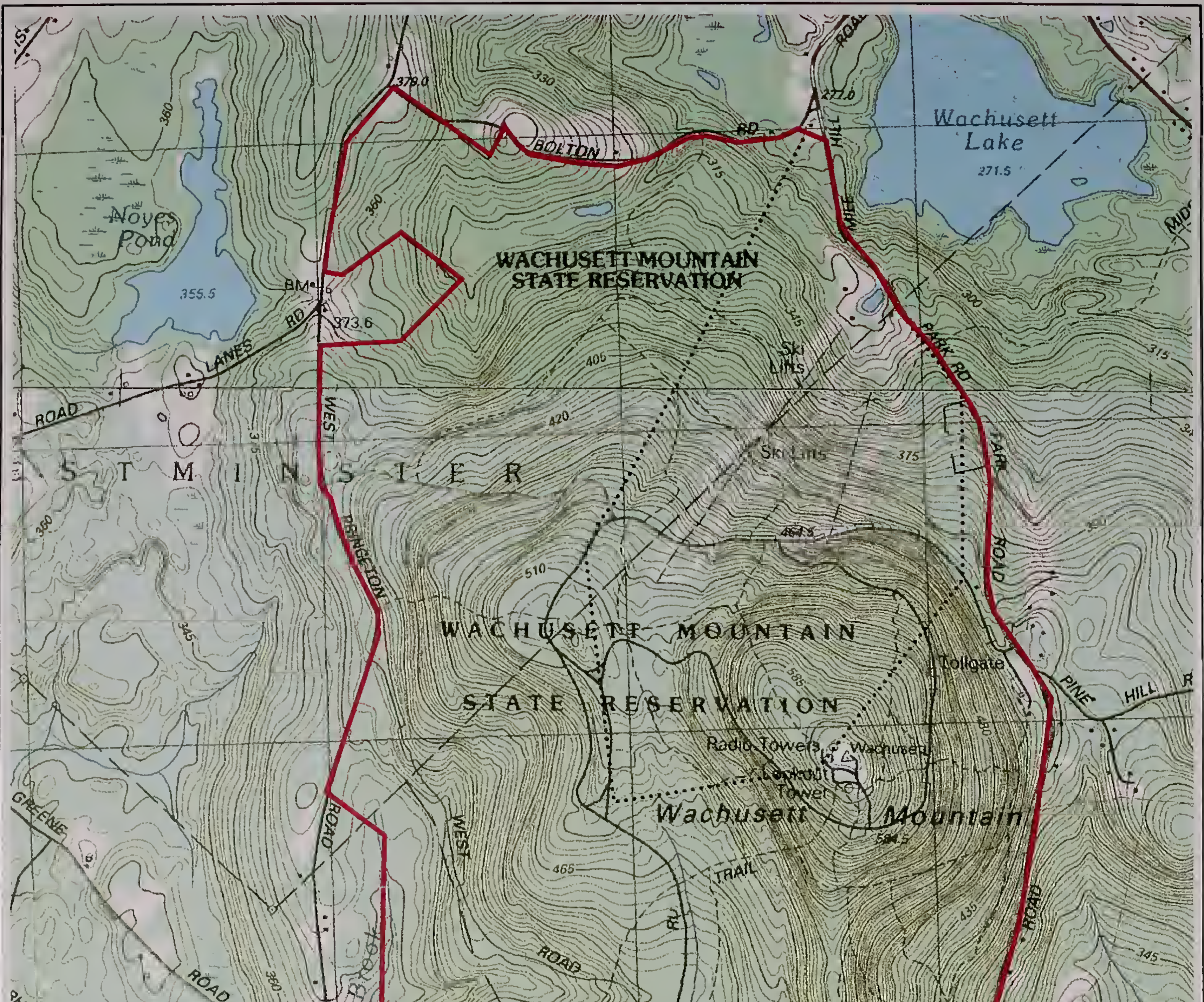

Figure 1-1

USGS Map

Massachusetts Department of Environmental Management
Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 100 200 400 feet
0 40 80 160 meters

LEGEND

— Wachusett Mountain State Reservation Boundary

••• Ski Lease Area

NB: This basemap is the latest coverage provide by the USGS, a federal agency. The map is useful for more detailed topography, then that available through MassGIS, however it should be noted that the USGS basemap also contains outdated information. This map should be cross referenced with the other maps provided in this report.

Map Prepared By: Harvard Design & Mapping Co., Inc.

Source: US Geological Survey Princeton and Westminister Quadrangle Maps

1.1 About DEM...

Although it is one of the smallest states in terms of size, Massachusetts has the eighth largest state forest and park system in the country. The Massachusetts Department of Environmental Management (DEM), the state's primary land management and natural resource planning agency, oversees the state forest and park system.

DEM is the largest landholder in Massachusetts, managing over 285,000 acres or about five percent of the total land area of the state. DEM's landholdings range from Mt. Greylock, the state's highest peak, to the beaches of Cape Cod. In between lie vast tracts of forests, lakes, and ponds where swimming, fishing, hiking, sightseeing, picnicking, and camping are popular.

DEM maintains a web page at www.state.ma.us/dem which provides further information on DEM's forest and park system.

1.1.1 DEM's Mission

The mission of the Department of Environmental Management is to exercise care and oversight for the natural, cultural, and historic resources of the Commonwealth and to provide quality public outdoor recreational opportunities which are environmentally sound, affordable, and accessible to all citizens.

To carry out its mission, DEM investigates, analyzes, and demonstrates the wise stewardship of the Commonwealth's natural, cultural, and historic resources; develops and maintains public access to such resources in the rural, suburban and urban areas of the Commonwealth; provides public recreation and educational programs; enhances the quality of these resources through statewide resource planning; protection, and regulatory programs; and manages, protects, and conserves all public lands, waters, and facilities of the Commonwealth that have been entrusted to the care of the Department and future generations.

1.1.2 Organizational Structure

The Department is organized into two divisions reporting to the Commissioner. The Division of Forests and Parks is responsible for day-to-day operations and resource management. The Division of Resource Conservation performs resource assessment, planning, design, construction and scientific services. In addition, an administrative staff in the Commissioner's Office handles fiscal, legal, human resources and other administrative support functions.

1.2 Management Authority

1.2.1 Legislative Authority

Establishment of the Wachusett Mountain State Reservation was initiated through State legislation with the passage of the Enabling Acts of 1899, Chapter 378, Sections 1-7, to "provide a fitting and creditable public park for the free use of its inhabitants"[2]. The First Annual Report of the Wachusett Mountain State Reservation Commission recorded the acquisition of 563.51 acres as of January 1901, and recommended continued land acquisition efforts and increased public access to the Reservation, while acknowledging the need to simultaneously protect and manage natural resources associated with the property.

Whereas management authority for WMSR was originally the responsibility of the Worcester County Commission, the state legislature transferred this authority to the State's Department of Natural Resources (DNR) through passage of the Acts of 1966, Chapter 658, Sections 1-5. The DNR was subsequently renamed the Department of Environmental Management (DEM) as part of a reorganization of the Executive Office of Environmental Affairs. In June 1977, DEM was authorized to lease a 450 acre area of the Reservation for the development of a ski area through Chapter 287 of the Acts of 1977. DEM consequently conferred responsibility for operation of the ski area to a private entity, while retaining stewardship authority over the Reservation as a whole.

A century has passed since the Commonwealth established Wachusett Mountain State Reservation. This century has seen remarkable changes in our attitudes toward natural and cultural resources, in our knowledge of the interdependency of species associations, in our recognition of impacts to natural and cultural resources that may result from human activities, and in our ability to manage these resources – and ourselves- in a manner which benefits both.

1.3 Previous Management Plans

DEM has prepared several management plans for WMSR since having been given stewardship authority. The first management plan for the Reservation was developed in 1967, immediately following the transfer of management authority from the Worcester County Commissioners to the Department of Natural Resources (DNR). In 1979 a draft management plan for WMSR was undertaken, which contained management recommendations focussing on silvicultural activities and a comprehensive inventory of existing conditions at that time. In 1985 DEM developed a document entitled Guidelines for Operations and Land Stewardship (GOALS) which contains a natural resource inventory, resource management recommendations, and a land stewardship zoning map for the Reservation. These documents have been reviewed and relevant information has been incorporated into the present document, while certain topics have warranted updated information and/or additional data collection.

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[2] Wachusett Mountain State Reservation Commission, First Annual Report. January, 1901. Wright & Potter Printing Co., Boston.

1.3.1 Status of 1985 GOALS Plan Recommendations

A number of recommendations regarding watershed protection, public access, sanitary facilities, the summit, the ski area, interpretive services, and forest and wildlife management were presented in the 1985 GOALS management plan. These recommendations are currently under revision in light of the changing conditions at WMSR and the length of time which has passed since these recommendations were originally made. A summary of the issues and recommendations of the 1985 GOALS management plan can be found in Appendix A.

1.4 Need for an Updated Resource Management and Protection Plan

The 1985 GOALS plan recommends "that this plan be reviewed in five years, or as necessary, to evaluate any significant changes in the natural or man-made environment of the Wachusett Mountain State Reservation"[3] All of the suggested 'triggers' for a revised plan have since been met, including not only the passage of over a decade, but more importantly, significant changes in the natural environment and proposed changes to the man-made environment. These significant changes include the 1995 discovery of Old Growth forest, infrastructure improvements which DEM is planning to undertake, and proposed expansion of the ski area, all within the context of intensifying demand for a range of recreational uses within the Reservation.

These changed conditions affect management decisions pertaining to proper stewardship of WMSR. Accordingly, DEM recognizes the need to prepare a new resource management and protection plan.

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[3] Massachusetts Department of Environmental Management. 1985. Wachusett Mountain State Reservation: Guidelines for Operations and Land Stewardship. Commonwealth of Massachusetts, Boston.

1.5 Public Participation

DEM has included a public participation component in the development of the present Resource Mangement and Protection Plan in order to solicit public input during preparation of the plan. The public process involved two public meetings which focussed solely on the RMPP and a survey questionnaire. The first public meeting was held on October 8, 1998 to inform interested citizens about the scope and schedule for the project. A questionnaire was initially distributed at that public meeting, and was subsequently made available through the WMSR Visitors' Center, through the internet on DEM's web page, and through circulation efforts undertaken by the general public. Survey distribution was not controlled in any manner, as the purpose of the survey was to elicit a broad range of public opinion on a number of topics, rather than a statistical 'vote'. A second public meeting was held on January 21, 1999 to provide the public with an overview of the draft document and an opportunity to submit written and oral comments. In addition to the public meetings convened specifically to present the status of the RMPP, the plan was also discussed at a number of meetings of the Wachusett Mountain Advisory Committee, all of which are open to the public.

1.6 Regional Context

1.6.1 Geographical Location

Wachusett Mountain Sate Reservation is located in North Central Massachusetts, straddling a municipal boundary shared by the towns of Princeton and Westminster. Within an approximately one hour drive from Boston and less than one-half hour from Worcester, WMSR is a choice destination for outdoor recreational pursuits by residents of these two major metropolitan areas. Further, WMSR is also favored by residents of the southerly neighboring states of Rhode Island and Connecticut, less than two hours away. The nearest hiking facilities comparable to Wachusett Mountain are Mount Monadnock in Peterborough, NH (approximately 25 miles northwest of WMSR) and Mount Greylock in Adams, MA (some 70 miles westerly of WMSR). While offering recreational resources of regional significance, WMSR is also used regularly by residents of its host communities, Princeton and Westminster.

Figure 1-2 illustrates the geographical location of WMSR in relationship to major cities, boundaries of states neighboring Massachusetts, and major highway routes. Proximity of WMSR to nearby open space and protected land is discussed in Section 4, Recreational Resources.

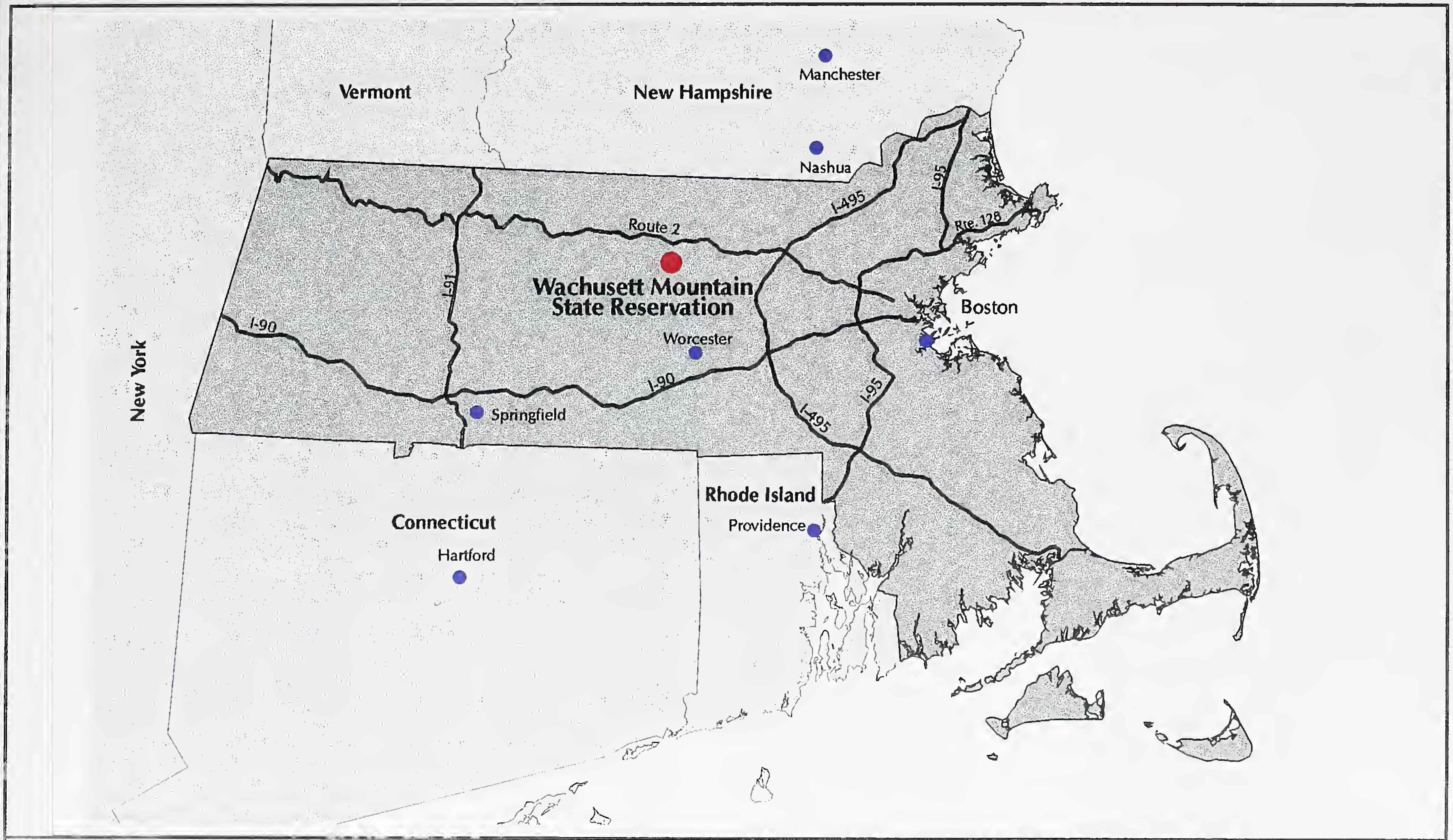

Figure 1-2

Regional Context

Massachusetts Department of Environmental Management
Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 2 4 8 miles
0 5 10 20 kilometers

LEGEND

● Wachusett Mountain
● Major Cities
— State Boundaries
— Major Roads

Map Prepared By: Harvard Design & Mapping Co., Inc.

Base Data: 1998 MassGIS

1.6.2 Host and Neighboring Communities

A brief discussion of population trends and open space characteristics of the host and neighboring communities around WMSR follows. Figures 1-3 and 1-4 illustrate the town boundaries and current land uses within communities in the vicinity of WMSR. Land use types shown on Figure 1-4 are derived from 1998 data from MassGIS[4]. Population across the 6 communities considered has increased substantially between 1980 and 1990, averaging at 23.6%. Despite the significant increase in population, open space has been preserved in each of these communities. A more detailed discussion of open spaces can be found in Section 4.

1.6.2.1 Princeton

The majority of WMSR is located within the northerly portion of the Town of Princeton. Princeton is the host community of approximately 1407 acres of the Reservation, including most of the hiking trail network, more than half of the alpine ski trails, and the summit itself. Including WMSR, approximately 52% of Princeton's 35.39 square miles is classified as open space[5]. The 1990 census of the Town of Princeton population was 3,189, as compared with 2,425 in 1980, representing a 31.5% increase in population over that decade. A 1994 population estimate for the town was 3,424, indicating the continuation of strong growth.

Recent traffic analyses performed in conjunction with the proposed ski area improvements indicate that approximately half of the traffic generated by the ski area travels through Princeton[6]. The present Resource Management and Protection Plan for the Reservation as a whole assumes that trip distribution patterns (i.e., percentage of total trips from a particular direction, not numbers of trips) are generally equivalent for year-round visitation as those associated with the ski area.

---

[4] MassGIS is the statewide geographic information system developed and maintained by the Executive Office of Environmental Affairs. Many of the maps contained in this document rely upon data provided through MassGIS.

[5] Source: MassGIS. Open space includes conservation land, recreation land, town forests, parkways, agricultural land, protected land around aquifers and watersheds, and cemeteries according to MassGIS definition.

[6] Vanasse Hangen Brustlin, Inc. 1998. Wachusett Mountain Ski Area Improvements Final Environmental Impact Report, EOEA #9690. Report commissioned by Wachusett Management Associates.

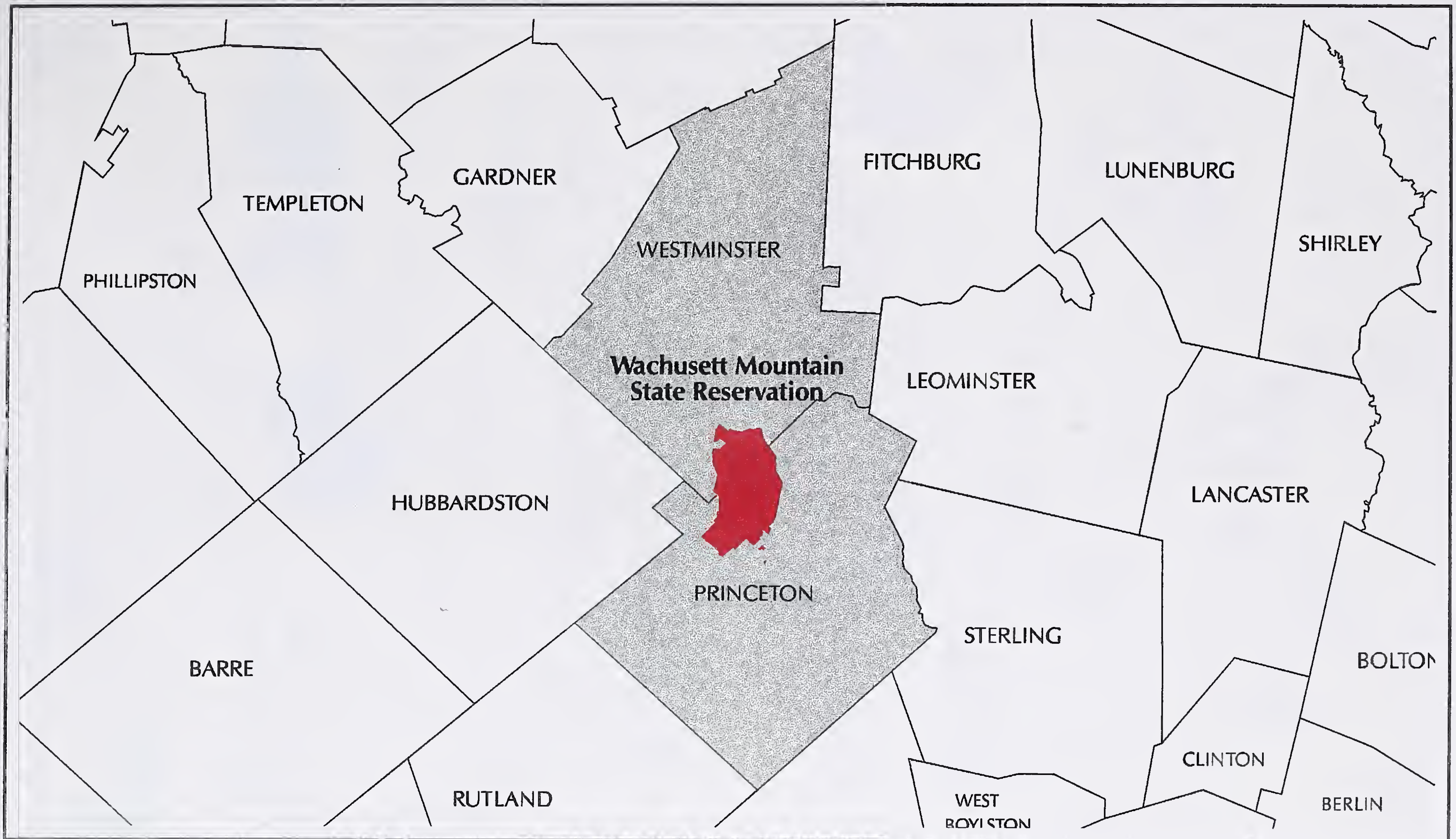

Figure 1-3

Host and Neighboring Communities

Massachusetts Department of Environmental Management
Wachusett Mountain State Reservation
Resource Management and Protection Plan

LEGEND

- 🟥 Wachusett Mountain
- — Municipal Boundaries

Map Prepared By: Harvard Design & Mapping Co., Inc.

Base Data: 1998 MassGIS

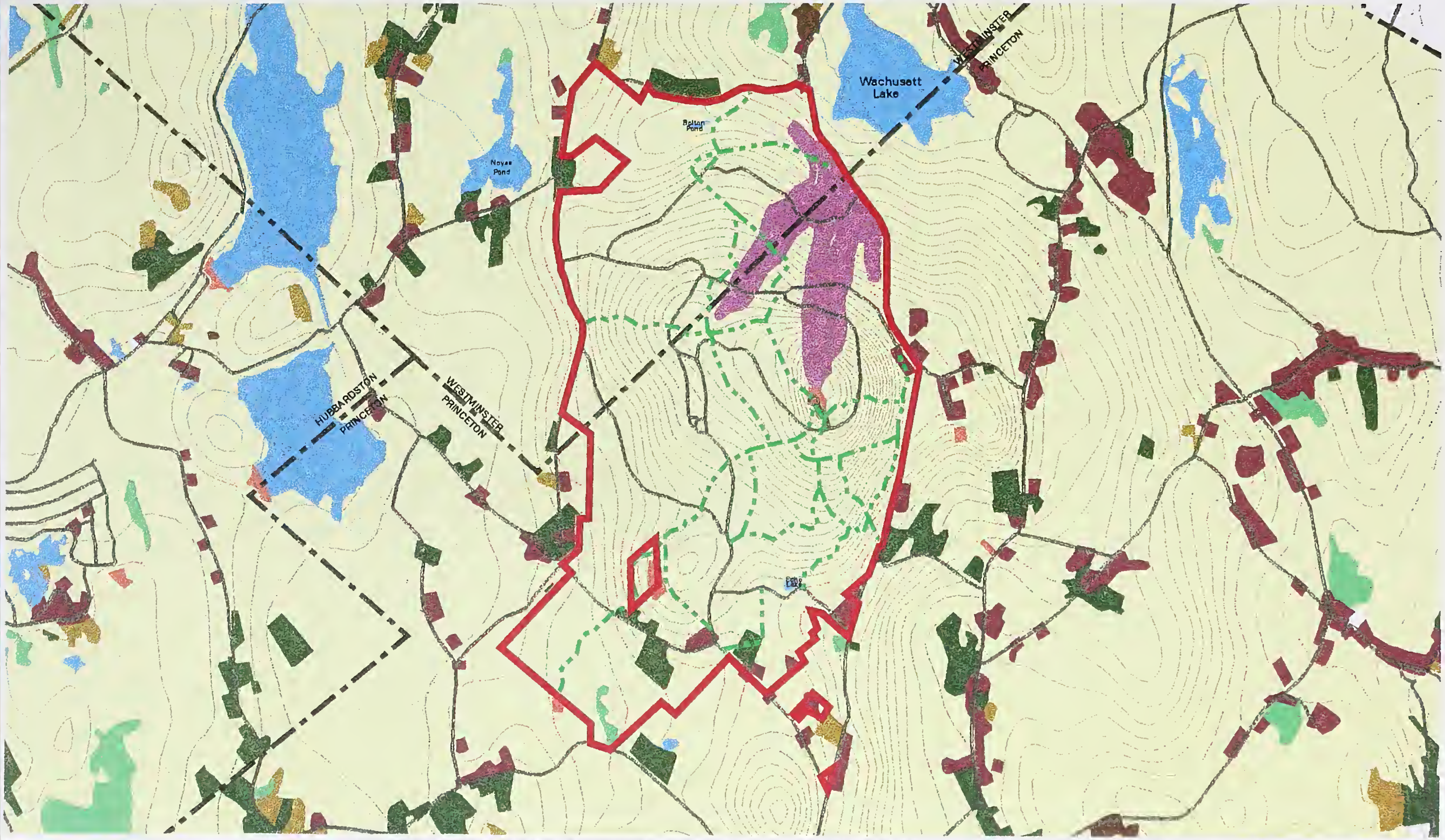

Figure 1-4

Current Land Use

Massachusetts Department of Environmental Management
Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 250 500 1000 feet
0 100 200 400 meters

LEGEND

- 🟥 Wachusett Mountain State Reservation Boundary
- — Town Boundaries
- ═ Roads
- - · Trails
- · · 10 m Contours
- 🟩 Agriculture
- Forest
- 🟩 Wetlands
- 🟫 Sand, Gravel, Rock
- 🟨 Open Land
- 🟧 Urban Open Land
- 🟪 Recreation
- 🟥 Residential
- 🟦 Water Bodies

Map Prepared By: Harvard Design & Mapping Co., Inc.

NB: Trail locations are approximate.

Base Data and Land Use Types: 1998 MassGIS

1.6.2.2 Westminster

Approximately 618 acres of WMSR are located within the Town of Westminster, including several hiking trails, less than 10% of the alpine ski trail network, but virtually all of the buildings and parking areas associated with the ski area. Including WMSR, only 23% of Westminster is classified as open space, the majority of which is for watershed protection, which allows very limited recreational use. WMSR is by far the most significant open space parcel within town limits. The population of Westminster has increased 20.5% between 1980 and 1990, with a 1990 population of 6,191, versus 5,139 in 1980 according to the US census report. Similar to Princeton, Westminster has also continued to grow rapidly, with a 1994 population estimate of 6,553

As with Princeton, utilizing recent traffic analyses performed in conjunction with the proposed ski area improvements[7], it is assumed that approximately half of the WMSR visitors travel through Westminster, with Route 140 providing direct access to Route 2, a major east-west highway.

1.6.2.3 Fitchburg

The City of Fitchburg, population 41,194 (1990) looks toward WMSR as the major contributor to Wachusett Lake, a public water supply for the city's residents and industry. Long urbanized, Fitchburg's population only increased 4.1% between 1980 and 1990. Although not contiguous with WMSR, Fitchburg boasts its proximity to the Reservation and its recreational facilities, describing the ski area as "the foremost winter recreational facility in central Massachusetts"[8]. Fitchburg is dotted with many public parks, as identified in its recent Master Plan, however these do not accommodate the same type of recreational uses as are available within WMSR.

1.6.2.4 Leominster

The City of Leominster, like its sister city of Fitchburg immediately to the north, is more urbanized than Princeton and Westminster, its neighbors to the west. Leominster's population rose 10.5% between 1980 and 1990, with the 1990 census reporting a population of 38,145. In contrast to Leominster's commercial center, its western limits are dominated by the 4,126 acre Leominster State Forest, less than 2 miles from WMSR and also owned by DEM.

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[7] Vanasse Hangen Brustlin, Inc. op. cit.

[8] Fitchburg home page, located at http://www.ci.fitchburg.ma.us/users/fitchburg/#v2020

1.6.2.5 Sterling

The Town of Sterling includes portions of the immediate watershed to Wachusett Reservoir, which is a secondary supply of drinking water for the metropolitan Boston area and several of its metropolitan communities. Accordingly, the majority of Sterling's open space is permanently protected watershed land. The population of Sterling has increased 19.1% between 1980 and 1990, from 5,440 to 6,481.

1.6.2.6 Hubbardston

The Town of Hubbardston contains approximately 4060 acres of protected watershed lands owned by the Metropolitan District Commission. These watershed lands contribute to the Quabbin Reservoir, the primary source of drinking water for the Boston metropolitan area. While a large percentage of Hubbardston is therefore protected from future development, recreational use of these watershed lands is restricted. Nonetheless, of the 6 communities considered in the vicinity of WMSR, Hubbardston has experienced the most spectacular increase in its population, rising 55.6% between 1980 and 1990. The 1990 census for Hubbardston documented a population of 2,797 residents. A 1994 population estimate reported 3,364 residents, a growth of nearly two-fold since Hubbardston's population of 1,797 in 1980.

1.6.3 Major Metropolitan Areas

Like the 6 communities immediately surrounding Wachusett Mountain, the populations of the nearby metropolitan areas of Worcester and Boston have also experienced substantial growth between 1980 and 1990. Although these cities have been urbanized for decades, their populations are still growing by a small percentage each year. Both of these areas are heavily developed with few alternatives for activities in a mountain setting, making Wachusett Mountain an important recreation area for residents of both cities. Any growth in population of these cites has a significant effect on the number of visitors to WMSR.

The city of Boston is located approximately 40 miles east of WMSR. Population growth in the Boston metropolitan area was not as great as in the communities surrounding Wachusett Mountain, but some growth was documented. Between 1980 and 1990, the population of the metropolitan area increased 1.33% from a population of 2,884,702 persons in 1980 to 2,922,934 persons in 1990. Between 1990 and 2000 the population is expected to increase 2.96% to 3,009,577[9] persons.

The city Worcester is less than 15 miles south of WMSR. Although it would appear that there is little room for growth in this urban area, between 1980 and 1990 the population of the Worcester metropolitan region grew 9.8% from 439,465 persons to 482,436[10] persons. The projected population for 2000 is 517,954 which represents a growth of 7.34% over the 1990 population for the region.

---

[9] Data provided by Metropolitan Area Planning Commission (MAPC), personal communication 5/11/99. The Boston metropolitan area includes communities within an approximately 20-mile radius around Boston.

[10] Data provided by Central Massachusetts Regional Planning Commission 5/11/99. The Worcester metropolitan area includes communities in an approximately 20-mile radius around Worcester.

SECTION 2.0

Natural Resources

2.0 NATURAL RESOURCES

2.1 Geology

Wachusett Mountain is the highest peak in eastern Massachusetts, rising to 2006′ above sea level. The mountain is a granodioritic monadnock, the remnant of an ancient mountain which originally rose alone above the surrounding plain and has since been eroded by weathering and glaciation. Wachusett's "obtuse, conical figure"[1] is a result of a resistant sill of tonalite, a tightly folded series of rocks, which forms the steep upper slopes of the mountain. These slopes dip gently (approximately 15°) to the east and are characterized by a series of exposed ledges[2]. Weathering of the bedrock by frost cracking has produced talus slopes in several locations on the mountain. These slopes are composed of gneissic boulders, and can be observed above the Visitor's Center on the east slope at 1450 feet (442 meters), or on the north side of the mountain above the Summit Road at 1750 feet (533 meters)[3]. The western flanks of the mountain are underlain by a less resistant sulfidic schist, which supports gentler slopes with less exposed bedrock and deeper soils than on the steep slopes. The peak of Wachusett Mountain is capped with gray schist surrounded by foliated granite[4].

Soils

Based on field studies conducted by the Natural Resources Conservation Service, seven primary soil types have been identified within the Wachusett Mountain State Reservation boundaries. These include Berkshire, Lyman, Paxton, Peru-Marlow, Ridgebury-Whitman, Hollis, and Tunbridge soils. The soils identified in the Reservation are the end products of the weathering of granite, schist, and gneiss which were deposited as glacial till.

---

[1] Dwight, T. 1821. Travels in New England and New York. Trip through Princeton in Journey to the White Mountains, Letter 26:2179-180 (1969 ed. Bellknap Press, Cambridge Mass.)

[2] Cogbill, C. V. 1996. An assessment of the historical ecology of the forests on the northeast slops of Wachusett Mountain, Massachusetts. A report prepared for Vanasse Hangen Brustlin, Inc.

[3] ibid

[4] Robinson P. and R.D. Tucker. 1992. A traverse across the "wild unknowns" of north-central Massachusetts from the Bronson Hill anticlinorium to the Fitchburg Plutons. P. 424-445 In Guidebook for the field trips(Robinson and Tucker 1992)

Soil coverage at Wachusett Mountain varies significantly with elevation. The summit of the mountain generally has little soil development. Surface deposits here are limited to a veneer of organic matter on boulders or thin stony material with some deeper pockets of Berkshire soil, a fine sandy loam containing many stones[5]. The steepest slopes are generally dominated by Berkshire and Lyman soils, the latter being a sandy loam containing larger rocks and boulders with many rock outcroppings. This soil is capable of supporting hardy ground cover and stunted, slow growing trees. Only the intermediate and lower slopes have sufficient soil depth and productivity to support reasonable rates of timber growth. In addition to Berkshire soil, the intermediate and lower elevations are characterized by Peru-Marlow soils and Paxton soils. These soil types are similar in composition to the Berkshire and Lyman soils but are underlain by a nearly impermeable sandy silt hardpan.

The remaining soil types occur sporadically throughout the Reservation, generally at lower elevations and are often characterized by extreme wetness at or near the surface.

2.2 Climate

Massachusetts is characterized by a humid continental climate which is largely a result of prevailing winds blowing from the western and central United States. These winds transfer interior continental weather systems to Massachusetts, lending this coastal state a continental climate rather than a characteristically marine climate. The greatest effect of this weather pattern is the large range between summer and winter temperatures. From 1961 to 1990, the mean January temperature at most locations in Massachusetts was below 32° F while July temperatures averaged approximately 70° F[6].

Due to its elevation, Wachusett Mountain's average summer and winter temperatures are slightly lower than those of the Central Highlands region in which it is located. Wachusett Mountain is also particularly susceptible to winter ice storms (freezing rain) due to its elevation, as well as rain and fog. Deposition of ice during winter storms is usually limited to the area above 1500 feet (457 meters) elevation. Tree damage at this elevation is frequently substantial.

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[5] Natural Resources Conservation Service. Brief Descriptions of the Soil Series and Miscellaneous Map Units recognized in Worcester County, Northwestern Part. United States Department of Agriculture, Worcester County Conservation District, Holden, MA.

[6] National Weather Service, 1998. Data obtained from National Weather Service homepage, located at http://tgsv5.nws.noaa.gov/

2.3 Water Resources

2.3.1 Surface Waters within WMSR

Surface water resources within the WMSR include intermittent and perennial streams, ponds, vernal pools and wetlands. These resources are contained within 4 sub-watersheds that ultimately drain into the Nashua River basin to the north and the Chicopee River basin to the south. The importance of the surface water resources within WMSR is underscored by the fact that the majority drain to public water supplies, the most significant of which, due to its proximity, is Wachusett Lake. The sections that follow describe and identify the water resource types that are found within WMSR.

2.3.1.1 Intermittent and Perennial Streams

There are numerous intermittent streams that originate on the steep sides of Wachusett Mountain, and several perennial streams within the lower elevations of the Reservation. Owing to the nature of the area, the intermittent streams are unvegetated and flow rapidly within narrow, steep and rocky channels. Steady flow from these intermittent streams is typically seasonal and can occur during the late autumn, winter, and early spring (spring snowmelt). Flows may also occur during drier seasons in response to moderate or severe precipitation. Groundwater can also seep into these channels either seasonally or year-round in a number of locations along their length. None of the intermittent streams within WMSR appears on USGS maps of the area, although they have been mapped by unofficial sources.[7].

Perennial streams occur on terrain that, in general, is of moderate steepness. Two branches of East Wachusett Brook originating in the reservation flow in a southwesterly direction, merge and cross Mountain Road as one stream. The northern most of these streams flows from Echo Lake, which is described below. The water from these two streams ultimately flows into the Stillwater River, which is a tributary of Wachusett Reservoir in West Boylston. A third perennial stream originates off the reservation from a small pond located north of Thompson Road. The unnamed stream flows northwest from the pond into the reservation and ultimately converges with West Wachusett Brook immediately west of the reservation boundary south of Greene Road. West Wachusett Brook flows to the northwest into Bickford Pond. Bolton Brook, which does not appear on USGS maps, is fed by a number of springs and seeps in the northwest portion of the Reservation, and flows into and then out of Bolton Pond.

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[7] The New England Orienteering Club (NECO) published a map illustrating the majority of WMSR, which illustrates a number of intermittent stream channels, however these have not been definitively confirmed.

2.3.1.2 Ponds

A number of ponds occur within the limits of the WMSR. Because of the steep terrain within the reservation all of these ponds are small. These permanent water bodies are summarized in Table 2-1; ephemeral pools are not included in this list.

Table 2-1 Ponds within WMSR

Name of Water Body	Approx. Size (ac.)	Location	Comments
Mirror Pond	0.2	Ski area complex	Man-made water body used for ski area operations
Bullock Pond	0.05	Ski area complex	Excavated basin used for ski area operations; formed at confluence of two intermittent streams and created to provide sediment trap; discharges to Sedimentation Pond
Sedimentation Pond	0.2	Ski area complex	Excavated basin; receives flows from Bullock Pond; created to allow fine sediments to settle before discharging to Mirror Pond
Snowmaking Pond	2	Ski area complex	Primary function for snowmaking supply
Bolton Pond	1.5	Northernmost extents of WMSR, adjacent to Bolton Pond Trail	Relatively remote pond fed by numerous springs and seeps; retained by historic fieldstone dam
Echo Lake	2	Southeastern quadrant, immediately adjacent to Echo Lake Road	Largest pond within WMSR; retained by concrete dam; used as watering hole for experimental breeding of deer and elk within WMSR during early 1900s

Table 2-1 Ponds within WMSR (continued)

Machis Pool	0.1	Intersection of Westminster Road and Administration Road	Small fire pond fed by unnamed stream; named after Machis family
Siplas Pool	0.05	Central/western portion of WMSR, approx. 200 feet south of West Road	Small fire pond fed by tributary to West Wachusett Brook; retained by earthen dam; named after former assistant supervisor of WMSR
Everett Pool	0.05	West/northwest portion of WMSR, along Balance Rock Road	Small impoundment of tributary to Bolton Pond
'The Bog'	0.05	Central portion of WMSR; adjacent to Summit Up Road	Isolated depression; vernal pool habitat
Summit Pond	0.13 (5,533 square feet)	Summit	Historical summit feature, utilized by vernal pool species; formerly thought to be spring fed but now believed to be fed primarily by surface runoff

2.3.1.3 Vernal Pools

Vernal pools are typically small isolated water bodies that seasonally pond water in the late autumn, winter and spring, but dry up during summer. These sensitive wetlands are essential breeding habitat for several species of amphibians and invertebrates, and are also important for other varieties of wildlife as well. Two vernal pools have been definitively identified within WMSR during field investigations unrelated to the present management plan . One of these occurs near the summit and the other is located along the Summit Up Road. Based on observation conducted during the fall/winter of 1998/1999 and informal reports, there are several other potential vernal pools within the Reservation, including Machis Pool, Everett Pool, and a small excavation adjacent to Administration Road. Egg masses in each of these pools were observed during field reconnaissance in the spring of 1999, and documentation has been submitted to the Natural Heritage and Endangered Species Program. As ephemeral water bodies which are typically isolated from other surface waters, vernal pools are primarily significant to wildlife, although from a water resources standpoint they also provide stormwater detention and infiltration functions. Section 6 of this document recommends definitive inventory efforts to formally certify vernal pools throughout WMSR, and establishes management recommendations to sustain the ecological integrity of these pools.

2.3.1.4 Wetlands

Many of the wetlands that occur within the limits of the WMSR are limited in size, bordering as narrow fringes on the high gradient, rocky intermittent streams that flow off Wachusett Mountain. The hydrology of a majority of these wetlands is provided by the surficial discharge of ground water in the form of springs and seeps.

Other wetland types occur within the reservation particularly in areas that are less steep or even level. Some of the areas where wetlands are known to occur include the areas surrounding Bolton Pond, Echo Lake and the relatively flat terrain that borders the perennial streams that occur in the southern portion of the reservation. Common wetland types that are known to occur within the reservation include red maple swamps, scrub/shrub swamps, and marshes. Near the intersection of the Semuhenna Trail and Summit Road is a small bog. While a majority of the wetlands have been mapped in detail within the ski area, the majority of wetlands that occur within the Reservation have not been formally delineated[8].

2.3.2 Public Water Supply Watershed Limits

Wachusett Mountain State Reservation lies within portions of the Nashua and Chicopee River basins. Within the reservation, surface waters contributing to the Nashua River Basin flow into 2 sub-basins. These sub-basins include the North Nashua and South Nashua. Within the North Nashua sub-basin, portions of two watersheds contribute water to Wyman Pond and Wachusett Lake. The area that contributes water to Wyman Pond is located in the northwest corner of the reservation, and the area contributing to Wachusett Lake is located in the northeast corner. Wyman Pond is intensively developed for water-based recreation and is surrounded by numerous summer camps and year round residences. Flowage from Wyman Pond enters Sawmill Pond which is a holding reservoir for the James River paper plant. Water from Sawmill Pond is diverted as needed for use by the James River Mills.

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[8] The aforementioned New England Orienteering Club map provides far greater detail on the location and extent of wetland resource areas than are documented by USGS quadrangle coverage, which was utilized for the 1985 GOALS plan.

Wachusett Lake is used as a public water supply for the City of Fitchburg[9]. The Wachusett Mountain ski lease area forms some 30% of the watershed of Wachusett Lake (Figure 2-1). In 1983 a diversion system was constructed to allow surface waters from the Snowmaking Pond to be diverted away from Wachusett Lake when turbidity levels are high. The diversion directs water through a culvert parallel to Mile Hill Road. Ultimately the diversions allows water to flow into a natural stream channel which is a tributary to Wyman Pond. This diversion is also used to channel runoff from the vegetated areas at the base of the ski area and from Parking Lot 1 away from Wachusett Lake.

A portion of a sub-basin located within the southeastern potion of the reservation ultimately drains to the Wachusett Reservoir, located in West Boylston, some ten miles from WMSR. Wachusett Reservoir is part of a public water supply system for metropolitan Boston operated by the Metropolitan District Commission (MDC).

The southwestern quarter of the WMSR forms a portion of a forth watershed. This area contributes water to the Chicopee River Basin The drainage from this area flows in a westerly direction into Bickford Pond, another source of drinking water for the City of Fitchburg. The overflow from Bickford Pond enters the east branch of the Ware River. Water from the Ware River is occasionally diverted into the Metropolitan District Commission's Quabbin aqueduct to supply drinking water to the Metropolitan Boston area.

2.4 Vegetation

2.4.1 Forest Cover Types

DEM has maintained records on forest stands at WMSR since 1967, and the 1979 draft management plan provides the most comprehensive inventory of cover types based upon field reconnaissance to date. As discussed later in Section 6, there is a need to supplement this inventory, both to update the survey to reflect current conditions, and more importantly to augment the inventory to consider species within the shrub and herbaceous layers. Notwithstanding, the 1979 inventory provides a critical framework for the present discussion of vegetative cover types, and for the development of a more detailed vegetative inventory under the recommendations of this management plan.

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[9] Vannasse Hangen Brustlin, Inc. 1998. Wachusett Mountain Ski Area Improvements. Final Environmental Impact Report, EOEA No. 9690.

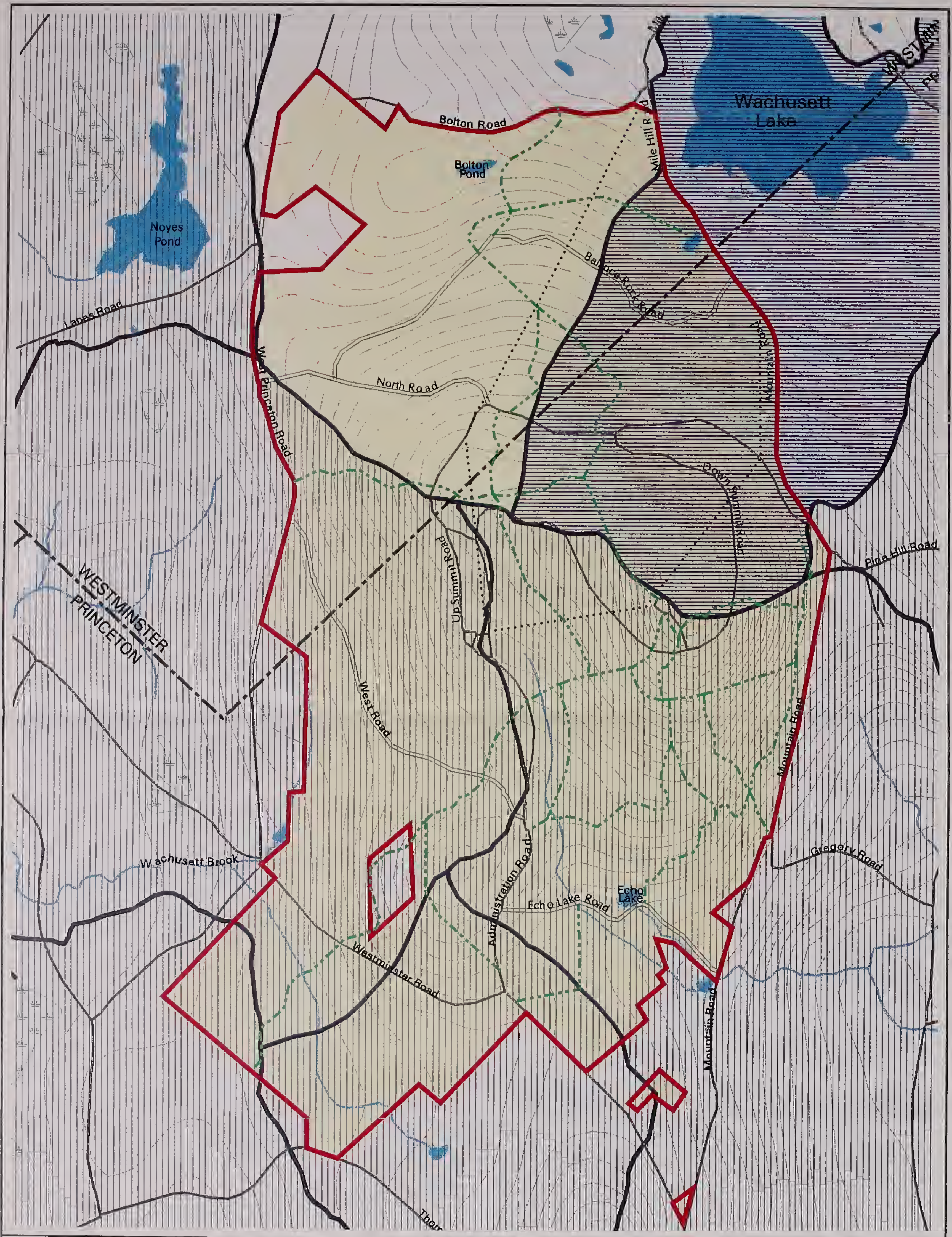

Figure 2-1

Water Resources

Massachusetts Department of Environmental Management

Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 100 200 400 feet
0 40 80 160 meters

LEGEND

▬	Wachusett Mountain State Reservation Boundary
▬	Town Boundaries
═	Paved Roads
═	Unpaved Roads
- -	Trails
—	10 m Contours
▭	Hydrography
▬	Watershed Boundaries
⋰	Ski Lease Area
▭	Wachusett Mountain State Reservation
▬	Water Bodies
⺌	Wetlands
☰	City of Fitchburg Public Water Supply
||||	MDC/MWRA WaterShed

Map Prepared By: Harvard Design & Mapping Co., Inc.

NB: Trail locations are approximate.

Base Data: 1998 MassGIS

The 1979 forest inventory identified 26 classes of forest cover within WMSR, the characteristics of which are detailed in the draft management plan prepared at that time. The 1979 data was geared toward describing forest cover for silvicultural purposes, which characterize stands not only by species types, but also by age classes. For purposes of the present plan, these cover types have been aggregated into nine categories by combining classes with the same dominant species, as identified in Table 2-2. The presentation of cover types in the present document is therefore a simplification of the 1979 data and does not represent more recent field inventory efforts. DEM does not anticipate the need to systematically update the 1979 forest inventory for all of WMSR, as the majority of the Reservation will no longer be managed for silviculture (see Section 6 for further discussion of restrictions on timber harvesting within WMSR)

It should be noted that the vegetation within the administrative limits of old growth forest on Wachusett Mountain includes several cover types. A separate discussion of old growth is provided in Section 2.4.2.

Figure 2-2 indicates the generalized limits of the vegetative cover types. As identified in Table 2-2; this figure is based upon mapping contained in the 1979 draft management plan.

2.4.2 Old Growth Forest[10]

In 1995, a stand of old-growth forest was identified on the upper northeast slope of the Wachusett Mountain State Reservation, within an area leased to Wachusett Mountain Associates (hereafter 'WMA', the private operators of the ski area; see Section 5.3.1 for further discussion) and under consideration for a proposed ski trail. This finding initiated a series of scientific studies examining the forests across the mountain. Subsequent to this research, DEM established an area of WMSR designated as the "Administrative Limits of Old Growth Forest", which is depicted on Figure 2-2. The following discussion includes an overview of research conducted on the mountain since the initial discovery of old growth forest, while recommendations for management and future research efforts are contained in Section 6.

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[10] Staff of Harvard Forest were retained to provide a summary of the initial discovery of old growth on Wachusett Mountain and to describe additional research that has taken place since that time. The complete text of the Harvard Forest report prepared in connection with the present Resource Management and Protection Plan is contained in Appendix C. This subsection provides a synopsis of that report, and includes many direct excerpts.

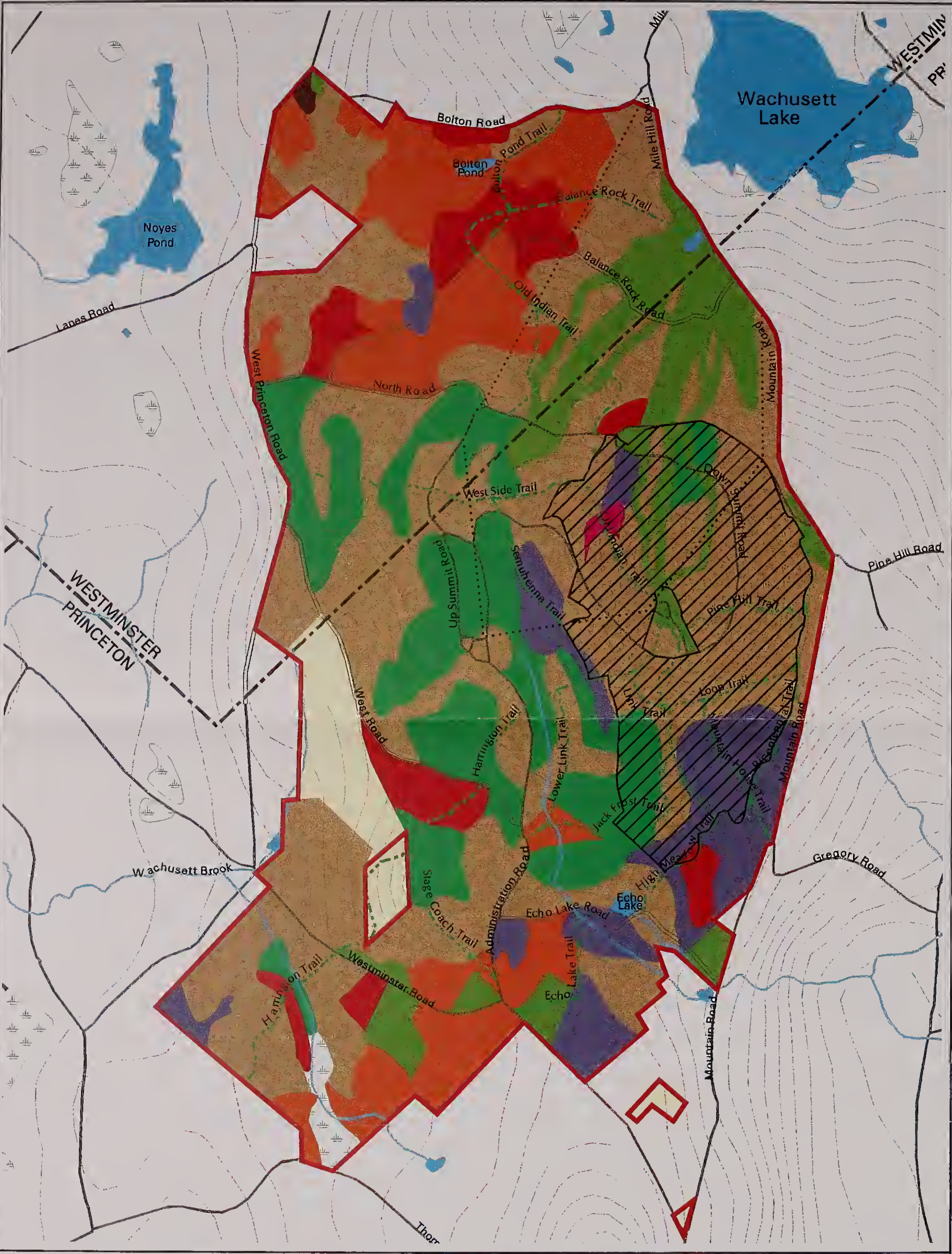

Figure 2-2

Vegetative Cover Types

Massachusetts Department of Environmental Management

Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 100 200 400 feet

0 40 80 160 meters

LEGEND

- Wachusett Mountain State Reservation Boundary
- Town Boundaries
- Paved Roads
- Unpaved Roads
- Trails
- 10 m Contours
- Hydrography
- Ski Lease Area
- Water Bodies
- Wetlands

- / / Administrative Limits of Old Growth
- No Inventory Available
- 🟩 Open Areas
- 🟥 Early Successional Woodland
- 🟫 Conifer Plantation
- 🟪 Northern Hardwoods
- 🟫 Oak Forest
- 🟩 Hemlock Forest
- 🟧 White Pine Forest
- 🟥 Red Spruce

Map Prepared By: Harvard Design & Mapping Co., Inc.

NB: Trail locations are approximate.

Base Data: 1998 MassGIS

Foster et al. (1996) Harvard Forest Report
Final Report on Old Growth Forests on Wachusett Mountain

Three ecologists from Harvard Forest, a research department of Harvard University, Dr. David Foster, Dr. David Orwig, and Dr. John O'Keefe were contracted by the Massachusetts Department of Environmental Management (DEM) to undertake a review of the old-growth forest area across DEM land on Wachusett Mountain (WM). This overview (1) provided a review of the Cogbill (1996) historical forest ecology report; (2) included extensive field reconnaissance to assess the extent and general age, structural, and compositional characteristics of old-growth forest areas within the reservation, including DEM land located outside the leased area; and (3) made recommendations for further, more detailed studies that would provide information on the developmental history, and long-term dynamics of the old-growth forest that would be pertinent to the oversight and management objectives of DEM.

The report was based on an introductory field excursion to Mount Wachusett with DEM personnel in November of 1995, two weeks of field studies conducted in the spring and early summer of 1996, interviews and discussion with Drs. Charlie Cogbill and Peter Dunwiddie [forest ecologists who have conducted the initial assessment of the forest for VHB and the Massachusetts Audubon Society, respectively), and extensive past experience in documenting and studying old-growth forest dynamics in New England and across northeastern North America.

Conclusions corroborated the Cogbill report and further identified and examined a large, intact area of old-growth forest that extended beyond the leased ski boundary and followed the steep upper contours of the mountain (above approx. 400 m above sea level). Reconnaissance of the upper slopes across most of the mountain indicated that sugar maple, yellow birch and red oak were commonly 150 to 250 years old, and that two red oak near the Old Indian Trail were 285 and 307 years, respectively.

The total acreage of old growth forest outside of the leased area was estimated to be from 35 to 40 ha (approximately 90-100 ac.), making Wachusett Mountain one of the only old-growth sites east of the Connecticut River and the largest documented site in the state (Figure 2-3). Proposed additional research included evaluating the successional status and long-term forest stand dynamics of the study area by examining the age, structure, and composition of vegetation in concert with dendroecological patterns of young and old trees and coarse woody debris. The complete text of the 1996 Harvard Forest report is contained in Appendix C.

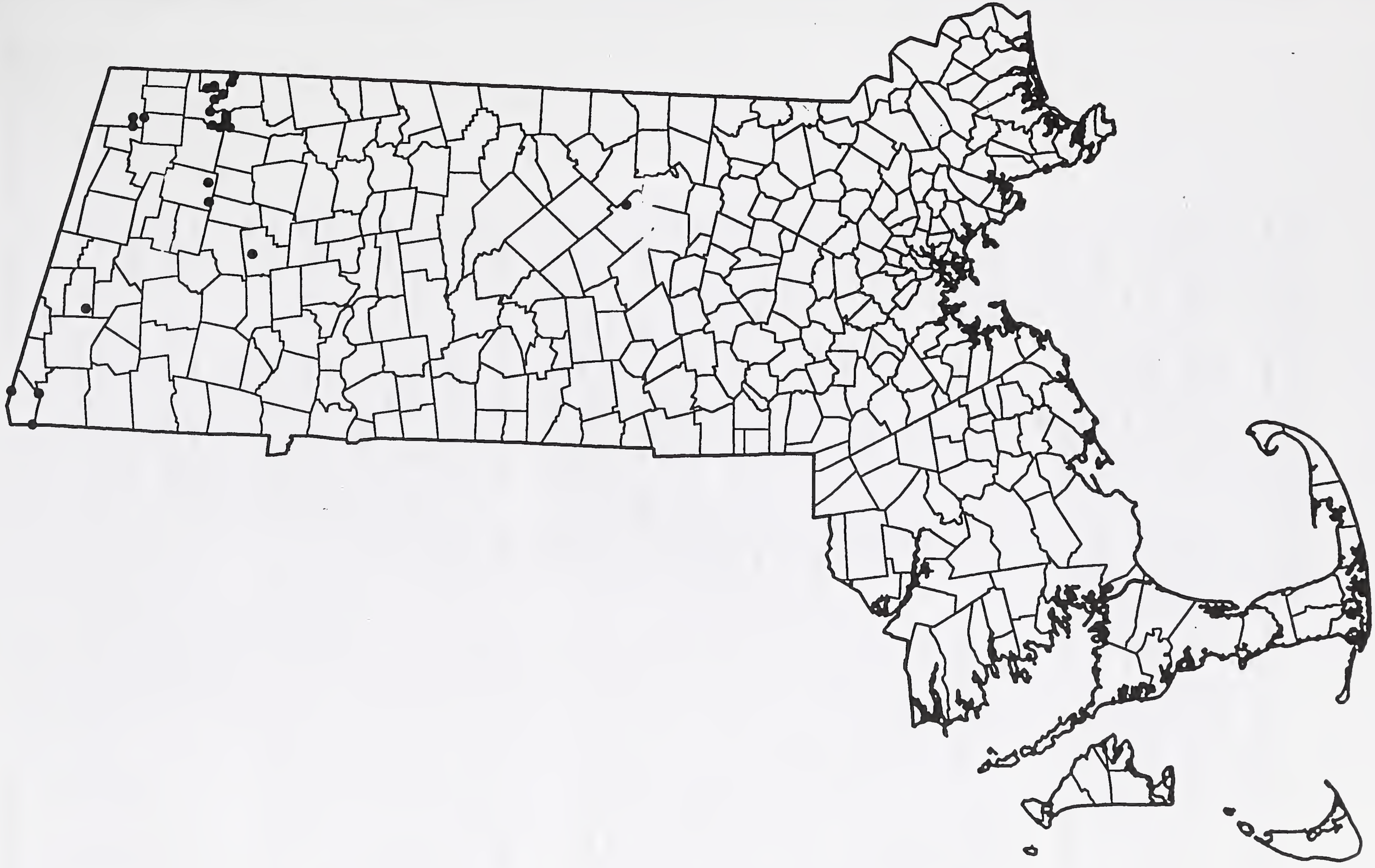

Figure 2-3 General location of currently recognized old-growth sites (at least 10 acres) in Massachusetts. Adopted from Dunwiddie and Leverett (1996).

Foster et al. (1997a) Harvard Forest Report
Impacts of Proposed Development on the Forests of Wachusett Mountain

In the spring of 1997, Harvard Forest ecologists accompanied DEM personnel to Wachusett Mountain in order to discuss two proposed development activities: (1) relocation of many of the towers from the open summit area to an adjoining, lower forest area and erection of a communications building; and (2) development of a new ski trail extension (proposed trail 8A) off of trail 8 (Figure 2-4). The following discussion includes separate results and conclusions for each area.

Summit Area The forest in the area of the proposed communications building site and south of the existing parking lot (Figure 2-4) contained overstory red oak, American beech, red maple, and a few hemlock with diameters ranging from 15-50 cm diameter breast height (dbh) and heights of 6-12 m tall. Within the proposed building area seven trees were cored, primarily red oak with one beech and hemlock. Sizes ranged from 15-46 cm dbh and ages from 63 to 145 years old. Throughout the remainder of the area an additional thirteen trees were cored including one shagbark hickory. Trees ranged from 17-51 cm dbh and ages ranged from 84 to 187 years old. Although this area contained mature trees it lacked the very old trees that characterize the old growth forest covering other parts of the mountain. Presumably the area had experienced a history of disturbance by human activity (it contained several multiple-stemmed trees, indicative of past cutting and is located 100-300 m from the open summit area, which contained a hotel beginning in the late 19th century) or natural disturbance in the last 200 years, and therefore did not meet the old-growth criteria of Cogbill (1996).

Proposed Ski Trail Expansion The forest located between Up Summit Road and Down Summit Road (see Figure 2-4); 419-495 m above sea level (a.s.l). is comprised primarily of red oak, sugar maple, yellow birch, with a few patches of hemlock and white ash. Many trees in the stand exhibited old-growth characteristics and ranged from 30-78 cm dbh. Several of the trees exceeded 200 years of age, including a large red oak that was 285 years old. A dominant feature of this area was the scattered yellow birch in the 50-70 cm dbh range, estimated to be from 150 to over 300 years old. This upper portion of the proposed expansion contained many mature trees and does not appear to have been cut in the past.

In contrast, the area below Up Summit Road (see Figure 2-4); 373-427 m above sea level exhibited characteristics of second-growth forests that were intensively disturbed in the past. Common overstory trees included red maple, yellow birch, black cherry, and white pine with a few scattered paper birch. The majority of trees were smooth-barked, multiple-stemmed individuals, indicative

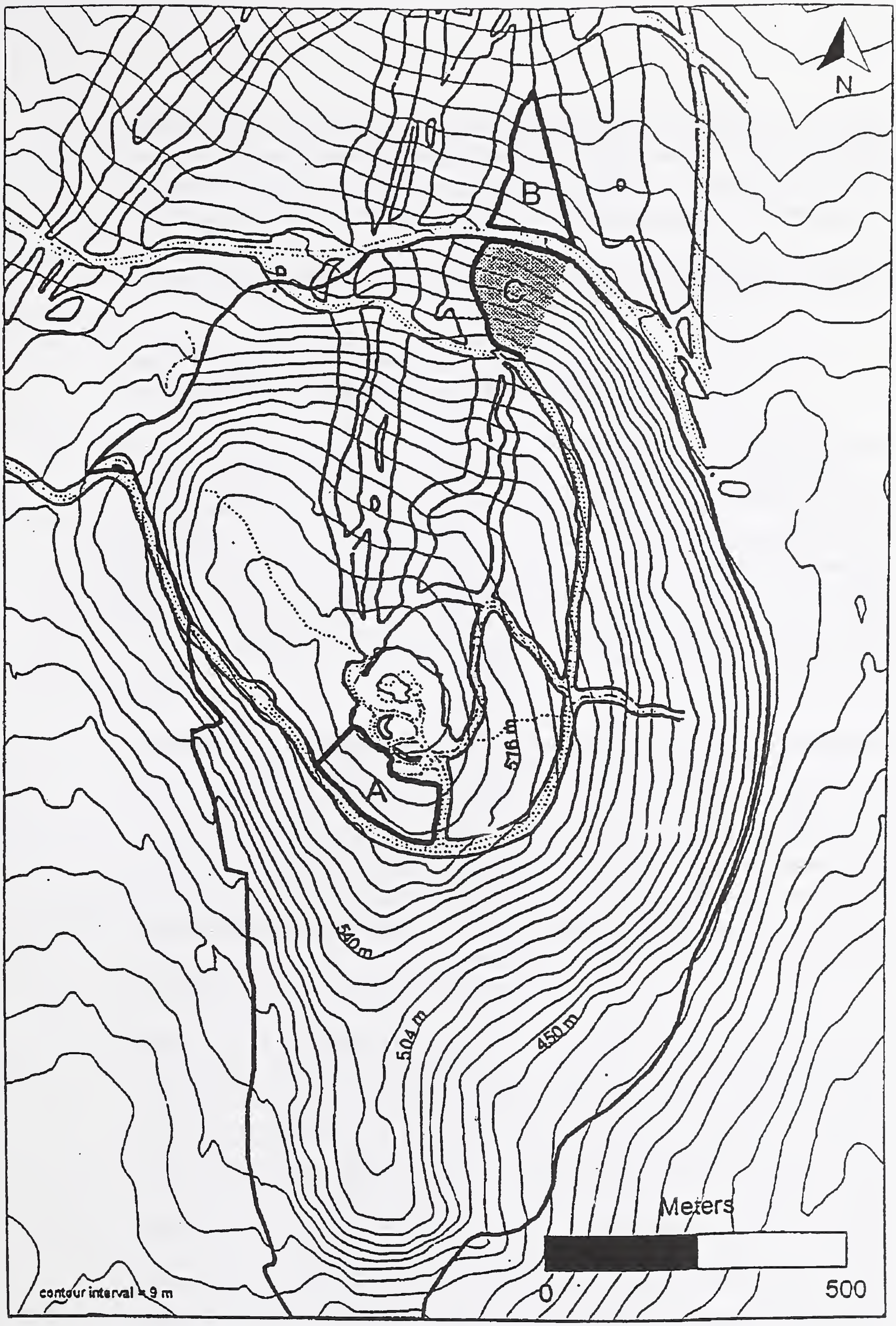

Figure 2-4. Location of study areas (enclosed by thick border) for (A) summit improvements, (B) originally proposed ski trail 8a extension (no longer under consideration), and (C) area of proposed ski trail extension remaining under consideration. Shaded area indicates area of Old Growth Forest verified by Harvard Forest Ecologists in 1997. The large boundary indicates area administratively designated as containing old-growth forest in the 1996 Harvard Forest Report.

of past cutting. In addition, the area was bordered on two sides by stone walls, further evidence of past agricultural land use. This area was documented by Cogbill (1996) as the Parker Pasture, which was still active in the later half of the 19th Century. One of the larger white pines in the area was aged at 94 years.

The complete text of the 1997a Harvard Forest report is contained in Appendix C.

Foster et al. (1997b) Harvard Forest Report
Old Growth Forest Monitoring on Wachusett Mountain

During the summers of 1996 and 1997, the Harvard Forest group intensively studied four distinct old-growth areas within the administrative limits of the old-growth identified in the Foster et al. (1996) report. The locations of these permanent plots are not presented in this report, and are available only to qualified persons conducting scientific research. Within each area, the age, structure, and composition of overstory vegetation was examined. The four old-growth areas were located on slopes >20% at similar elevations of 427 - 518 m a.s.l., but differed substantially in aspect, forest structure and composition as follows.

Old Indian (OI) old-growth area: The OI overstory composition was comprised of a mixture of hardwood species including beech, red oak, red, sugar, and striped maples, and yellow birch. Thickets of mountain maple, striped maple and witch hazel were common in the sapling layer, and black bindweed and spinulose wood fern were the most common understory species. Structurally, red oaks were the oldest and largest trees in the stand, with several individuals >64 cm dbh and exceeding 300 years old. Many beech and yellow birch were >150 years old while the maple species were typically less than 100 years old and dominated the smaller size classes.

Eastern Talus (ET) old-growth area: Due to the abundance of rock boulders (talus), this forest had low basal areas and overstory stem densities. Yellow birch was the most abundant tree species on this site, although red oak and red maple were also common in the overstory. Mountain maple and striped maple were again found in dense sapling thickets and yellow birch saplings were also found in high abundance. Polypody was commonly found blanketing the rock surfaces on this site, along with wood ferns and sarsaparilla. A few large red oaks >150 years old were interspersed among yellow birch representing a wide range of size and age classes. Many birch trees exceeded 250 years of age on this site, and the oldest tree found to date on the entire mountain (a yellow birch that was 369 years of age at breast height) was found here. Smaller individuals of striped and red maple have become established more recently at this site.

Southern Talus (ST) old-growth area: The ST site contained large, scattered boulders and the overstory was dominated by red oak, red maple, and yellow birch. Due to the open, rocky nature of the site, witch hazel and striped maple were abundant in the sapling layer. The understory was comprised of many species, although only black bindweed, mountain aster, and sarsaparilla were locally abundant. Red oak represented the oldest and largest trees at this site, including several over 250 years old. A few beech, hickory, and sugar maple exceeded 200 years, while smaller-sized yellow birch and red maple were typically <60 years old.

Hemlock (H) old-growth area: Shade-tolerant hemlock dominated this forest, although scattered individuals of red oak and a few other hardwoods were found throughout the stand. Due to the high density and basal area of hemlock, there was virtually no sapling layer and only a sparse understory layer of herbaceous species. Structurally, hemlock occurred across a broad range of size and age classes (20 - 71 cm dbh and 115 - 255 years old;). Many red oak and black birch trees exceeded 200 years in age and one red oak exceeded 300 years.

May (1998) Lichen Report
Lichens of the Old-Growth Forest Administrative Area, Wachusett Mountain State Reservation

Philip May of the Farlow Herbarium in Cambridge, MA surveyed lichens at 9 sites on the mountain representing all habitat types and study areas mentioned in the Foster et al. (1997b) and Cogbill (1996) reports. This survey yielded much higher species diversity (150 species in 72 genera) than was found in well studied second-growth forests elsewhere in the state. Included in the list were 16 old-growth indicators from northern New England and several species rarely collected in Massachusetts, including one possibly new to science (*Rhizocarpon aff. anperum*). According to May, the presence of many unusual lichen species within these forests, despite possible negative effects from past air pollution, suggested that the mountain is serving as a lichen refugium. A copy of this report is provided in Appendix D.

2.4.2.2 Significance of Old Growth Resource

The forest structure and age-classes of trees found in the nearly continuous forest matrix on the upper slopes of Wachusett Mountain are extremely rare. Several trees found on the mountain including red oak, black birch, and yellow birch are at or very near the maximum longevity known for the species. Of particular significance is the number of red oak exceeding 250-300 years of age, which may be the most yet described anywhere in the eastern United States. The Administrative Limits of the Old Growth Forest at Wachusett Mountain encompass a total of 160 acres. In addition, these forests have provided new insight into the appearance and structure of old-growth on harsh sites that does not meet typical expectations of cathedral-like groves of old-growth trees. The rocky, inaccessible upper slopes of the mountain are frequently exposed to wind and ice storms and have produced forests with distinct morphological characteristics including twisted, gnarled trees with stunted canopies that have persisted for several centuries. These stands represent some of the largest forest remnants that have not been irrevocably altered due to catastrophic disturbances or European settlement clearing. In summary, Wachusett Mountain is an extremely interesting and ecologically significant site, particularly due to the close proximity of a wide range of forest types located at different aspects.

2.4.3 Floristic Inventory of Wachusett Mountain State Reservation

The list of plant species for the mountain as a whole derives from several sources, the most extensive and authenticated being field surveys performed in 1997 and 1998[11]. This information was supplemented by species lists included in the 1979 draft management plan for WMSR (which was subsequently reproduced in the *Wachusett Mountain Ski Area Environmental Impact Study* completed by Wallace, Floyd, Ellenzweig, Moore, Inc.), species lists in the 1998 Final Environmental Impact Report by Vanasse Hangen Brustlin, Inc., records of the Massachusetts Natural Heritage Program, and field observations provided by the Massachusetts Audubon Society.

Although the most comprehensive list of WMSR flora compiled to date, the list (contained in Appendix E) should not be considered complete, as the Mountain has not yet received the level of study required to assemble a thorough (>95% complete) inventory. Likewise, information on frequency and habitat associations is preliminary. Records of state-listed species have been excluded from this list, but any such observations have been reported to the Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program (NHESP). Comments include information on abundance and habitat, and apparent misidentifications are noted. Finally, the accuracy of records of species reported in other sources has not been verified. The most questionable of these have been eliminated, but some misidentifications may remain within the comprehensive species list contained in the appendices.

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[11] Field work was performed by Dr. Robert I Bertin, who is concurrently working on a flora of Worcester County.

A total of 520 species and varieties have been reported from WMSR. These include 33 ferns and fern allies, 14 gymnosperms, 344 dicotyledons and 129 monocotyledons. Native species total 407 and introduced species 113, or 22% of the total.

2.4.4 State-Listed Flora

The most current list of state-listed flora known to occur within WMSR includes three vascular plants. There have been no reports of federally-protected plant species. The NHESP compiles and manages data relevant to rare species locations. Information on file with NHESP is protected under the Public Records Law (M.G.L. c.66, s.17D), and site specific data is provided on a need-to-know basis only. NHESP records were made available for this document, and specific surveys were conducted for several of the previously reported state-listed species. Historically, WMSR has supported a total of seven plant species with a current status of endangered, threatened, special concern and the informal designation of 'watch-list' species. It should be noted that some of these historical observations are from nineteenth century records; no attempt has been made under the present report to verify the accuracy of these original records, and these species are no longer included on the official NHESP list.

DEM will collaborate with NHESP to ensure that management protocols provide protection to known locations of state-listed species. Details concerning the species and their locations are not provided in this document to prevent unintentional dissemination of information which may threaten such species as a result of collection, or other human-induced impacts.

2.4.5 Representative Natural Areas

WMSR supports one of the twelve Representative Natural Areas (RNAs) that have been established across the Commonwealth under DEM's Wildlands Program (see further discussion under Section 5.4.2.2). This RNA is a northern red oak stand of approximately seven acres located in the northwestern portion of WMSR, near the Bolton Pond trailhead. This area is recognized as a prime example of a mature northern red oak stand, comprised almost entirely of specimens in excess of 70 feet tall, which are of a size and quality uncommon in central Massachusetts. Further description of this RNA is provided in an undated DEM publication entitled "Massachusetts Wildlands: A Guidebook to the Commonwealth's Natural Areas", available through DEM.

2.4.6 Introduced and Invasive Vegetation

Introduced and invasive species have increasingly become a concern among land managers, who recognize the damages that certain non-native species may cause for indigenous communities and native species. The Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program (NHESP) published a pamphlet in 1998 entitled "A Guide to Invasive Plants in Massachusetts". The primary purpose of this publication is to assist the public in the identification of invasive species, while it also provides a brief discussion of control measures for the most noxious plants.

The plant species list compiled for Wachusett Mountain State Reservation includes 22% non-native species, or a total of 113 of the 520 species identified to date. Many introduced species do not pose any threat to indigenous vegetation, but some exhibit strongly aggressive characteristics.

"A Guide to Invasive Plants in Massachusetts" provides the following definition:

> A Typical Harmful Invasive Plant
>
> 1. Grows and matures rapidly
> 2. Spreads quickly
> 3. Can flower and/or set seed all season
> 4. Has no known diseases or pests to control it
> 5. Thrives in many habitats
> 6. Is difficult to remove or control

The most aggressive non-native species known to exist within WMSR include Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculata*), Morrow's honeysuckle (*Lonicera morrowii*), black locust (*Robinia pseudoacacia*), and multiflora rose (*Rosa multiflora*). Management recommendations for the control and/or eradication of these species are provided in Section 6.

2.5 Wildlife

2.5.1 Background

In the absence of recent field observations, the present wildlife inventory assumes a correlation between types of vegetative cover documented to occur within WMSR and the presence of previously observed species. It was not possible to undertake an intensive wildlife field inventory of the WMSR under the auspices of this management plan. Therefore, existing information was utilized to the maximum extent possible to describe the wildlife at the WMSR.

A large amount of information on the potential occurrence of wildlife species at WMSR was modeled after species/vegetative cover correlations documented by DeGraff and Rudis[12]. The vegetative cover types of WMSR were matched against the species/habitat matrices of DeGraff and Rudis to determine which species of amphibians, reptiles, birds and mammals are likely to occur at the WMSR.

This analysis was supplemented with actual wildlife field observations conducted in support of the 1998 summit resources inventory (which incorporated a 1997 bird inventory by the Eastern Massachusetts Hawk Watch), the Wachusett Mountain Ski Area FEIR (which presented wildlife inventory data compiled in 1996), a Massachusetts Audubon Society bird census performed in 1998, and species lists presented in the WMSR 1979 Management Plan. In combination, these documents provide the most comprehensive inventory of wildlife species compiled to date that are either known to occur or which could potentially occur within WMSR.

It should also be noted that WMSR is one 67 locations throughout the state identified in the Massachusetts Wildlife Viewing Guide, a collaborative publication developed by a multi-agency committee, and the Reservation is frequented by both amateur and professional naturalists. Efforts to compile information from volunteer sources are recommended in Section 6.

The inventory presented in this document is divided between major faunal groups based on the level and detail of information available. It should be noted that species lists included in Appendix F to this RMPP primarily rely upon the presence of preferred habitat as an indicator of the probability of such species actually being present within WMSR. While authenticated field observations are available for numerous bird species and butterflies (both of which are popularly observed by amateur naturalists), very little documentation is available for other faunal groups, aside from inventories undertaken for specific areas of the Reservation (e.g., summit and ski are lease).

2.5.1.1 Species List Organization

Species lists for the faunal groups discussed below are provided in Appendix F. These lists are organized to identify whether each of the listed species has been directly observed, or if it is presumed to occur based upon the presence of preferred habitat type within WMSR. The lists also identify which of the references utilized recorded each of the species. In addition, the lists correspond to the vegetative cover types identified in Section 2.4, in order to facilitate future wildlife survey efforts.

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[12] DeGraff, R.M and D.D Rudis. 1986 New England Wildlife: Habitat, Natural History, and Distribution. General Technical Report NE-108. Broomall, PA: U.S. Department of Agriculture, Forest Service,

2.5.2 Types of Wildlife Habitat Provided by WMSR

2.5.2.1 Mammals

To date, 59 mammalian species have been observed and recorded at Wachusett Mountain Reservation. The 1979 management plan included a list of species observed by and/or reported to DEM staff up until the publication of that document. This list was subsequently reproduced in the 1979 Environmental Impact Study for Wachusett Mountain Ski Area and in the 1985 GOALS Plan, without any supplemental field verification. More recent mammalian field inventories have been performed on the summit and within the limits of the ski area.

Mammals which have been documented to occur within WMSR are predominantly common species supported by habitat types which are widely available within eastern Massachusetts, particularly second growth forest. The most unusual habitat found within WMSR in relation to its regional setting are the talus slopes and ledges, which provide preferred denning habitat for some mammals, such as porcupine. There are neither current nor historic records of the occurrence of any mammals within WMSR which are recognized under Massachusetts Endangered Species Act Regulations [321 CMR 10.00]. A list of mammals which have been documented or presumed to occur within WMSR is provided in Appendix F1.

2.5.2.2 Birds

WMSR is a favored location for bird-watching, and species lists are frequently compiled and updated by various organizations including the Massachusetts Audubon Society, the National Spring Migratory Count, the Eastern Massachusetts Hawk Watch, and individual enthusiasts. Additionally, avian inventories have been conducted in anticipation of improvements to the summit facilities and in association with the proposed ski area expansion. The summit inventory included a breeding bird survey as well as other bird observations, and was conducted in May and June of 1998. The ski area inventories, performed in the late spring 1994 and June 1998, do not distinguish between breeding birds and transients.

Northeastern Forest Experiment Station. 491 pp.

Because raptors tend to follow mountain ridges to take advantage of rising currents of warm air called thermals, Wachusett Mountain is a major "bird of prey" migratory route along the eastern flyway. The migration south occurs during September, October, and November, and a maximum of 20,000 raptors has been recorded in one day. Hawk migrations have been observed and recorded for decades, and all migratory eastern raptors have been observed and catalogued from the summit. The appeal of the summit area to hawks and to hawk watchers alike has more to do with regional macro-topography, however, than with the physiography or habitat features of the summit study area itself. A census of migratory birds has also been conducted on portions of the reservation as part of the National Spring Migratory Count held May for the years 1995 through 1998. A list of birds which have been documented or presumed to occur within WMSR is provided in Appendix F2.

2.5.2.3 Reptiles and Amphibians

The diversity of habitats found within the WMSR suggests that the property supports most of the common to moderately uncommon herpetofauna inhabiting eastern Massachusetts. However, areas of herptile concentration such as open canopy wetland and woodland/meadow ecotones are sparse and widely distributed.

Salamanders: The spotted salamander (*Ambystoma maculatum*) is widely distributed on the mountain with its principal limiting habitat feature being the distribution of suitable vernal pool breeding habitat. A population of large, presumably age-biased individuals was recently documented associated with the summit and two breeding pools there. Three species of stream salamander occur in the WMSR with recent documentation. The northern dusky (*Desmognathus f. fuscus*) and two-lined (*Eurycea bislineata*) are ubiquitously distributed through the reservation in areas of semi-permanent seeps and stream channels. The state listed northern spring salamander (*Gyronophilus p. porphyriticus*) has been documented from the reservation since the late nineteenth century and as recently as 1995 from a single locus. This secretive species is presumably more widely distributed among the semi-permanent streams and seeps it inhabits where it feeds on the stream salamander species listed above as well as other prey. The red-spotted newt (*Notopthalmus v. viridescens*) is widely distributed and common throughout the waters of the reservation from the summit to the permanent ponds around the base. This species' biphasic (terrestrial/aquatic) life history and its toxicity to fishes allow it to exploit a wide range of aquatic and terrestrial habitats found within the WMSR.

Frogs: Frog species previously documented on the WMSR are all species of broad distribution in eastern Massachusetts. The gray tree frog (*Hyla versicolor*), a common inhabitant of unspoiled woodlands and wetlands is presumably present in association with the permanent to semipermanent surface pools within the reservation, although it does not appear on previous species lists. Most of the ranid frogs (bull, green, leopard, pickerel) most likely inhabit permanent wetlands at lower elevations of WMSR. The remaining ranid species, the wood frog (*R. sylvatica*), has been observed breeding near the summit and at lower elevations. This species' global distribution extends beyond the arctic circle and so it is likely to breed in any wetland on the mountain with a sufficient hydroperiod.

Turtles: Two of the most common species of turtle found in the region inhabit wetland habitats on the mountain. These are the common snapping turtle (*Chelydra s. serpentina*) and the eastern and midland painted turtle (*Chrysemys picta picta* and *C. p. marginata*) and hybrids. Both species inhabit the permanent surface waters of the WMSR with the exception of the summit pool and both are capable of occasional long overland movements. The spotted turtle (*Clemmys guttata;* Spec. Con.) is reported in previous GOALS plan herptile lists, however no records for the species exist with the NHESP. Limited areas of potential wood turtle (*Clemmys insculpta*; Spec. Con.) habitat also occur in the northern portion of the reservation and this species maintains moderate to robust populations in areas outside of Rte. 495 in Massachusetts. It may therefore occur within the WMSR among the lower elevation wooded streams and surrounding terrestrial habitat.

Snakes: Members of this group are often secretive and poorly documented, even from areas experiencing considerable human presence. These are expected to be predominantly found in ecotone areas such as the ski slope clearings among other edge habitats. However, one previously-identified species, the northern water snake is most probably restricted to the permanent ponds and wetlands of the reservation.

A list of reptiles and amphibians which have been documented or presumed to occur within WMSR is provided in Appendix F3.

2.5.3.4 Invertebrates

Very little documentation of invertebrates has been compiled for WMSR with the exception of butterflies, which are annually inventoried by the Massachusetts Butterfly Club (MBC). As a supplement to data which exist on butterflies, the Wachusett Mountain Summit Natural and Cultural Resource Inventory and Analysis also provides a brief discussion revealing the dearth of other invertebrates within the summit study area (though omitting reference to the ubiquitous mosquito and black fly). The summit report does, however, document the presence of several insect larvae within a vernal pool, as well as reporting dragonflies observed within the limits of the study area. An inventory of invertebrates documented within WMSR is provided in Appendix F4.

2.6 Scenic Resources

Wachusett Mountain State Reservation provides a broad variety of scenic resources. Views from the summit are by far the most popular aspect, and this vantage position is commonly given precedence over all other scenic resources. The present discussion acknowledges the importance of views from the summit, but also seeks to underscore the variety of visual qualities afforded by other parts of WMSR.

2.6.1 Massachusetts Landscape Inventory

The 1982 Massachusetts Landscape Inventory, a survey compiled by DEM of the Commonwealth's scenic landscapes, identifies portions of WMSR as having 'distinctive' or 'noteworthy' visual qualities. The Massachusetts Landscape Inventory focuses only on those areas of the Commonwealth which exhibit the finest scenery throughout the state. Under the methodology used to develop the inventory, 'distinctive' landscapes are areas of the highest visual quality in the Commonwealth; only 4% of the total land area of Massachusetts has been categorized as distinctive. 'Noteworthy' landscapes are the second tier of areas with high visual qualities, and comprised about 5% of the land area of Massachusetts when the inventory was developed in 1982. DEM is currently updating the scenic landscape inventory.

2.6.2 Summit

The peak of the summit provides long vistas in nearly every direction. Certain viewsheds contain unique features (such as large bodies of water, mountains with distinctive profiles, and the Boston skyline), and therefore define the most desirable viewing positions. The most attractive views are generally toward the north and northwest, as these vistas exhibit numerous topographical peaks, occasionally interspersed with bodies of water. Views to the north are also very important for monitoring of the migratory path of hawks each autumn. The view to the east is popular for the glimpse of downtown Boston that may be discerned. The vista to the south has few distinguishing characteristics.

Several structures on the summit presently degrade views, including the fire tower and multiple communications antennae, as well as the security fencing which surrounds this infrastructure. In addition, vegetation to the north/northwest has begun to block views in that direction, however this vegetation also serves a beneficial function of screening ski lift equipment located just below the summit.

2.6.3 Scenic Overlooks

In addition to the vistas provided by the summit itself, several scenic overlooks have been historically maintained. The most accessible of these are three overlooks located along the vehicular access road to the summit, and a fourth overlook located along North Road, a wide gravel trail open to pedestrians and mountain bicyclists. There are also several locations along hiking trails where scenic views have been maintained, including one along Loop Trail, and another along Harrington Trail, roughly halfway between the Up Road and Administration Road. Harlow Overlook, an historic stone and timber shelter along the summit Down Road, once provided views toward the east, however the viewshed is presently blocked by secondary growth forest.

2.6.4 Trails/Woodland Views

While long vistas are the most impressive visual resource provided by WMSR, trails provide visitors with more intimate views of an array of natural resources, from talus slopes to dark hemlock forests, often complemented by fragments of history manifest by an extensive network of stone walls. Woodland views are ubiquitous along the trail system, and vary substantially depending upon many factors. Influential factors may include the time of year (i.e., whether vegetation is in leaf, dormant, or in bloom), type of overstory and understory within the immediate vicinity, presence of water, cultural features such as stone walls, and topography.

2.6.5 Water Views

Views containing ponds and streams are found at several locations throughout WMSR. Visitors often linger where there are water features to observe wildlife or other natural processes. Views of water tend to prompt feelings of tranquility and quietude, embodied by a reflective surface or the sound and movement of rushing water. Water bodies within WMSR are modest in size, the biggest pond being only about two acres and the largest stream perhaps six feet in width.

The most frequented ponds include Mirror Pond, the Summit Pool, Echo Lake and Bolton Pond. These are very different in character, due both to their surroundings and the level of activity within the immediate vicinity. Mirror Pond and the Summit Pool are both highly manipulated bodies of water, the former surrounded by mown lawn, the latter by a mortared stone wall, and both are located in areas which are subject to high levels of activity, proximate to roadways and parking areas. In contrast, Echo Lake and Bolton Pond are largely natural in appearance (though dammed), and are only accessible by hiking trails. Many trails also offer views of perennial and intermittent streams, either gently traversing a forest floor, or carved into steep slopes.

SECTION 3.0

Cultural Resources

3.0 CULTURAL RESOURCES

3.1 Background

A cultural resources reconnaissance survey has been conducted in order to develop a base line inventory of archaeological sites and historic structures within the boundaries of the Wachusett Mountain State Reservation.

The identification of existing cultural resources entailed review of previous reports, histories, maps, files maintained by DEM, and the MHC site files. Several key sources of information identified and reviewed include: *Wachusett Mountain State Reservation GOALS Plan.* (DEM); *Draft Environmental Impact Report, Ski Area Expansion.* (EOEA #9690); *Reconnaissance Archaeological Survey and Traditional Cultural Properties Consultation for Proposed Improvements of the Ski Area, Mt. Wachusett.* (Timelines); *Wachusett: Wachusett Gatherings from Then and When.* (Sinclair); *Historic and Archaeological Resources of Central Massachusetts.* (MHC); and, *Public Planning and Environmental Review: Archaeology and Historic Preservation.* (MHC).

Informant interviews have been conducted with Mr. Warren Sinclair and other individuals with knowledge of the area. Discussions occurred with members of the Nipmuc Tribal Council for their insights. Because the Reservation encompasses over 2,000 acres of land, a detailed field investigation has not been performed under the scope of the present RMPP. Rather, field reconnaissance focussed on evaluating the existing conditions of identified historic structures, the existence of known archaeological sites, and gathering data to develop cultural resource constraint mapping (archaeological sensitivity, historic structure locations, etc.).

3.2 Historical Context

Located in the central uplands of Massachusetts, in the northern portion of the Town of Princeton, Wachusett Mountain rises 2,006 feet above sea level. The summit, the highest point in Massachusetts east of the Connecticut River, provides commanding views of points as far distant as Boston. The name Wachusett is an Algonquin word meaning "by the great hill." During the prehistoric and early historic periods, the mountain served as a gathering point for local Native American tribes. During King Philip's War (1675-76) the mountain became a recruiting and staging center of sorts for Native Americans who gathered to launch attacks against European settlers. In the nineteenth century, the mountain became a popular tourist destination and was ultimately purchased by the state and set aside as a reservation for the enjoyment of the public.

Like many other upland towns in Worcester County, Princeton was first settled in the middle of the 18th century. The area within the current town limits was part of the twelve-mile-square tract that was purchased from the Naquag Indians in 1686. The entire tract was initially established as Rutland in 1714. Due in part to the area's rough terrain, intensive European settlement was delayed until the second half of the eighteenth century. Princeton was established as a district in Rutland's "East Wing" in 1759, and settlement occurred rapidly in ensuing years. The town was incorporated in 1771, and by 1776 there were about 700 people living there. The town's area increased several times over the course of the following century with the annexation of part of Hubbardston in 1810, some adjoining unincorporated lands in 1838, and part of Westminster in 1870. By the late eighteenth-century, Princeton had developed into a prosperous agricultural settlement of numerous Colonial- and Federal-style farmhouses set within a bucolic landscape.

The land surrounding the mountain was first divided into lots following the end of King Philip's War. These lots always excluded the mountain itself, and it wasn't until an auction of Province Land in 1762 that the mountain was assessed at a value of fifty pounds and designated as a parcel. The mountain ultimately became the property of Timothy Ruggles, Esq. with the stipulation that he pay two pence an acre tax for three years. When Ruggles sided with the British, all of his personal property, including the mountain, was confiscated. The entire mountain next became private property when it was given to the Reverend Timothy Fuller in 1768 by the Province as compensation for being the first settled minister of Princeton. The mountain was next owned by Ezra Cary, who purchased it in June of 1795 from Reverend Fuller. In June, Cary sold the "Great Wachusett Hill" to local resident and Lieutenant Governor Moses Gill. Prior to 1805, the mountain was sold to Thomas Boyleston, and following Boyleston's death that year, a writ was issued against his property. The property was appraised and placed under the administration of ward Nicholas Boyleston. In 1818, Boyleston sold the property, including the mountain, at public sale to his attorney and Justice of the Peace Nathaniel Paine to pay off Thomas's debt. Paine immediately sold the property back to Nicholas Boyleston for $5.00. Following Boyleston's death in 1847, the mountain was sold by his executors to John Brooks of Princeton.

Wachusett Mountain became a popular tourist attraction after the establishment of regular stagecoach service between Boylston and Ware, and through Princeton, in the 1820s. The stagecoach made the mountain accessible to travelers from Boston and other regional urban centers. Most came during the summer to enjoy the cool breezes and beautiful vistas of the surrounding countryside afforded by the summit. During the first half of the century, the mountain attracted such notables as author and naturalist Henry David Thoreau who wrote of camping on the summit; poet Ralph Waldo Emerson; writer Louisa May Alcott; naturalist Frank Bolles; and abolitionist William Lloyd Garrison.

During the second half of the nineteenth-century Wachusett Mountain emerged as one of Massachusetts' most popular inland tourist destinations. Several factors led to its increase in popularity. Improved railroad transportation following the Civil War meant that Wachusett Mountain was easily reachable from Boston for day trips and the summit afforded a cool respite from the heat of the inner city. Toward the end of the nineteenth century, an increase in naturalist ideals embracing unspoiled nature drew people to the mountain to hike its trails and visit the summit to enjoy the views. Numerous hotels and boarding houses were opened in Princeton during the second half of the century to cater to the increasing tourist traffic. Some of the largest were the Pine Hill House; Pratt's Cottage, opened in 1867; and Mount Pleasant House and Howard House, both opened in 1868. At the base of Wachusett Mountain, the Wachusett House and Mountain House were both opened in 1856.

In 1866, local entrepreneur William G. Morse established a concessions booth on the mountain summit to cater to visitors during summer months. Morse's business proved lucrative, and in 1870 he erected a small stone house known as the "Summit House." In 1874, a group of local businessmen formed the Wachusett Mountain Company with intention of capitalizing on the increasing tourist traffic on the mountain summit. The company purchased the mountain from Hiram Blood in 1875 and began making improvements. The Company constructed a road, which today is part of the Down Road from the summit, and enlarged Morse's stone house into a tourist hotel that was also known as the Summit House. A barn for carriage horses was constructed the following year.

Despite the improvements, the hotel was not an immediate success and in 1877, the Wachusett Mountain Company was forced to declare bankruptcy. The Company's property, including the hotel, was subsequently sold at auction in 1879 to Charles Brigham of Fitchburg. In 1879 Brigham enlarged the hotel and constructed a bowling alley just below the summit of the mountain, westerly of the summit house (shown on Figure 3-2).

In 1882 the property was sold to P.A. Beaman & Son, who had previously owned the Wachusett House at the base of the mountain. Beaman erected a three-story, 40-feet square building in 1884-85. Often referred to as the second Summit House, it was the central attraction of the summit, which by that time was being visited by as many as 30,000 visitors a year. Beaman & Son conducted a general hotel business at the summit in the summer months until the State of Massachusetts enacted Section 1 of Chapter 378 of the Acts of 1899, which authorized the establishment of a state reservation. Figure 3-1, an 1898 map of the Town of Princeton, indicates the Summit House and access road, and attributes ownership under P.A. Beaman.

Wachusett Mountain was the second property established as a State Reservation in Massachusetts. A year before it was acquired, the Commonwealth created Mount Greylock State Reservation. Like Greylock, Wachusett was placed under county jurisdiction with three commissioners appointed to oversee the area. As authorized by the Acts of 1899, the initial purchase of land for the reservation was secured on April 17, 1900 and consisted of the 533.4 acres that comprised the Beaman property. Figure 3-2 presents a plan and profile of the "Mountain Road" (now known as Summit Road) as it existed at the time the State acquired the property. This plan also shows the location of several structures on the summit itself. The property included the top of the mountain and some portions of the side slopes. An additional area that included a ravine deemed important to the overall beauty of the park complex, was later taken under the commission's authority from Samuel F. Mason and Thomas H. Russell, bringing the total acreage to 563.51.

In 1907 the Reservation Commission decided to rebuild and modernize the hotel. The Commission hired architect J.C.F. Mirick to prepare plans for this purpose. Work on the new hotel began in September of that year by dismantling and rebuilding the old ell, reusing as much lumber as possible. The third Summit House, as it was known, was opened for guests in June 1908. In 1919 the Summit House reported its best season and continued to make profits through the 1920s.

The onset of the Great Depression brought a decline in tourism. By the middle of the 1930s overnight use of the hotel had dropped considerably. The hotel restaurant, a souvenir stand, and an observation room on top of the hotel remained open, but overnight lodging was ultimately discontinued.

Projects undertaken by the Civilian Conservation Corp (CCC) and the Works Progress Administration (WPA) during the Depression left an indelible imprint on the mountain. During the late 1930s, a new, one-way road, known today as the "Up Road," was constructed by the CCC from the ox-bow to the summit. Two ski trails, Balance Rock and Pine Hill, were constructed in the early 1930s along with Bullock Lodge, a warming shelter for skiers. The CCC was also responsible for the construction of several stone observation platforms, three stone barbecue fireplaces, and a number of retaining walls on the summit. Major improvements on the mountain by the WPA included the construction of Parker Lodge on the summit and Harlow Lookout on the Down Road.

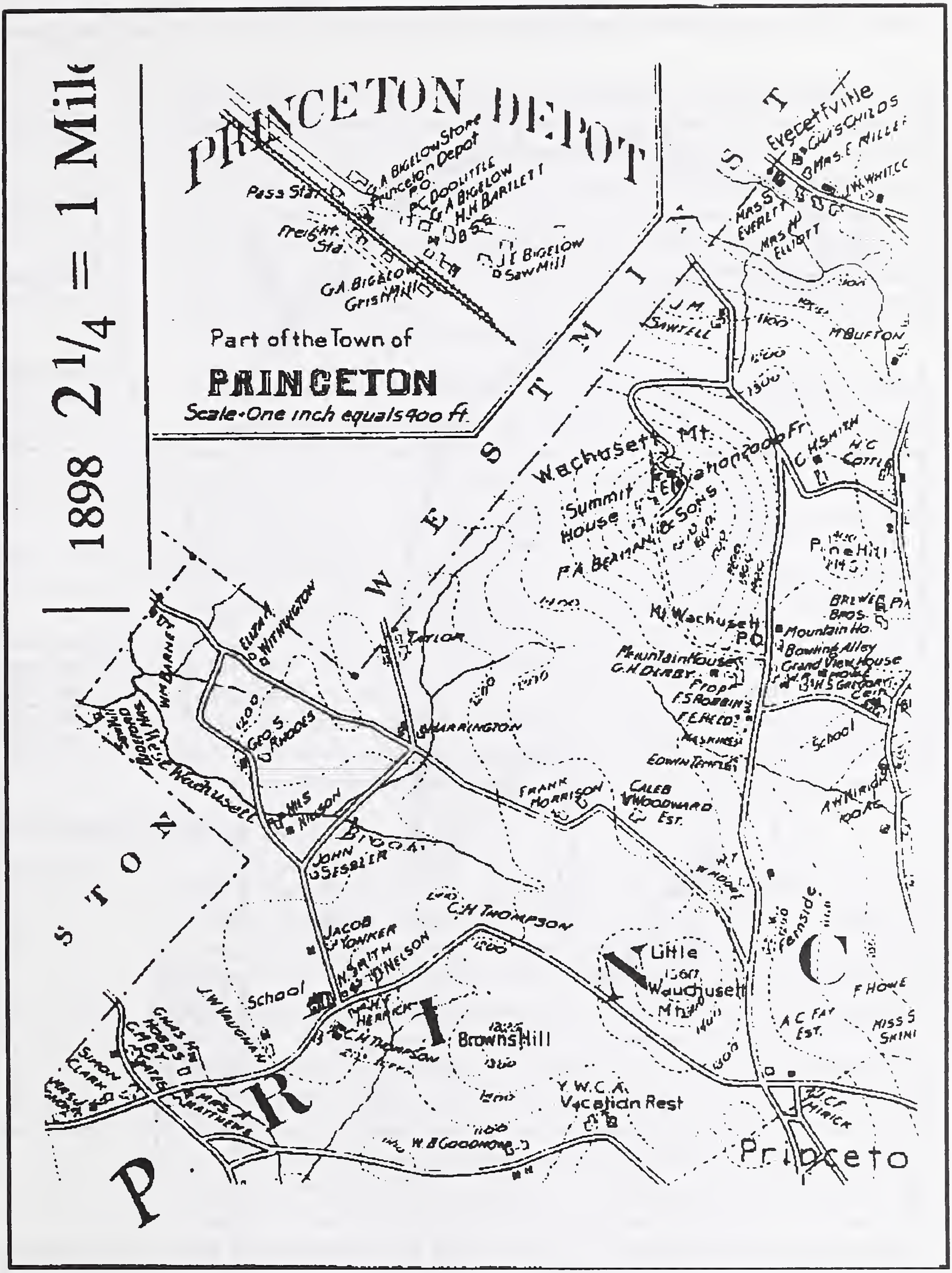

Figure 3-1 An 1898 map of the Town of Princeton, indicating the Summit House and access road, and attributing ownership under P.A. Beaman

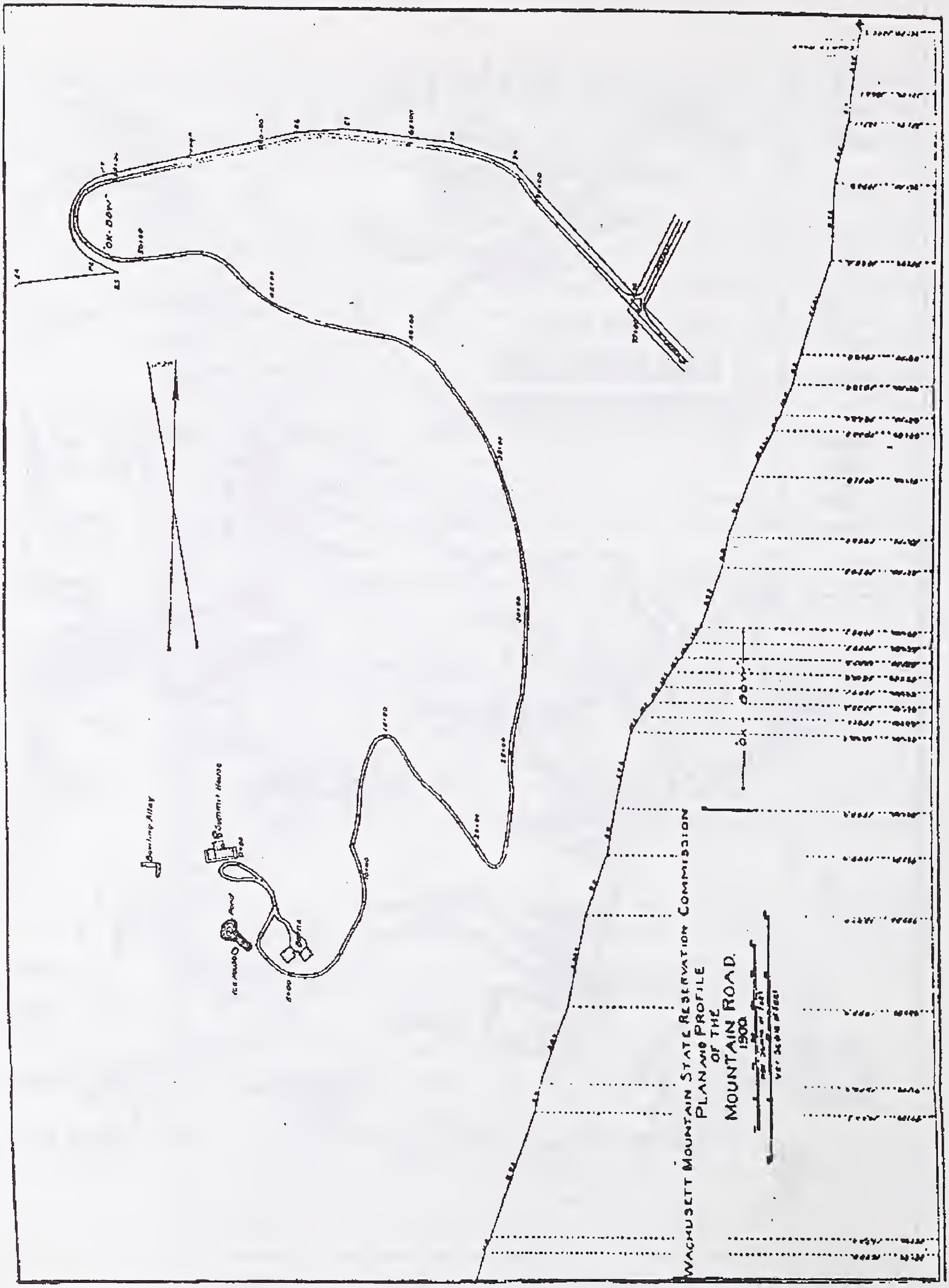

Figure 3-2 Plan and profile of the "Mountain Road" (now known as Summit Road) as it existed at the time the State acquired the property

Following World War II, visitation to Wachusett Mountain increased for a period, but then went into slow decline during the 1960s and 1970s. By 1962 a lift had been built and the pond at the base of the mountain was created for snow making. In 1967, management of Wachusett Mountain State Reservation was transferred from Worcester County control to the state Department of Natural Resources by an act of legislature, and in 1968, the state elected to lease that portion of the Reservation used as a ski area to Wachusett Mountain Associates, a private group. The Summit House was closed in the late 1960s and burned to the ground in December 1970.

Wachusett Mountain has experienced a rebirth in the past two decades. Riding a renewed wave of enthusiasm for appreciation and preservation of outdoor resources, Wachusett Mountain has seen its visitor count increase steadily over the years. Whereas 30,000 people a year visited the Summit House at its peak in the 19th century, that many people often visit the summit on a weekend in the autumn today to enjoy the beautiful fall foliage and expansive views, or to admire flocks of migrating birds. The John H. Hitchcock Visitor Center was constructed in 1975 at the base of the mountain to welcome visitors to the park. The combination visitor center/administration building was named for avid outdoorsman and chairman of the Wachusett Mountain Advisory Council from its inception in 1969 until 1983. As further examples of the resurgence in outdoor recreational pursuits, an extensive network of hiking trails have been established which wind their way from the base of the mountain to the summit, and skiing at Wachusett draws thousands to its slopes every day in the winter.

3.3 Historical Resources

Historic resources within the Wachusett Mountain Reservation include standing structures associated with the development of the mountain during the nineteenth and early twentieth centuries. The summit was used as a prominent orienting site for early land surveys undertaken in eastern Massachusetts beginning in the 1830s and several survey markers remain. The Down Road, which was initially constructed in 1874, is the oldest identified historic feature. Summit Pond, a manmade body of water on the mountain summit, also may date to as early as the late 1870s. The Superintendent's House was constructed in 1902 near the intersection of Echo Lake and Mountain roads. This structure is presently scheduled for rehabilitation under DEM's curatorship program, described further below and in Section 5. During the 1930s, the CCC and WPA made numerous improvements to the reservation. Historic structures associated with the CCC include the Balance Rock and Pine Hill ski trails, Bullock Lodge, the Up Road, and a number of stone retaining walls, fireplaces, and observation platforms on the mountain summit. The WPA was responsible for the Parker Lodge on the summit and Harlow Lookout, a viewing pavilion constructed of stone and timber downed in the 1938 hurricane.

The Summit, including the WPA Parker Lodge and the CCC stone walls, fireplaces, and lookouts, has the potential to be listed in the National Register of Historic Places as a district. Properties with potential for individual listing include Bullock Lodge, Harlow Lookout, and the Superintendent's House.

3.3.1 Rehabilitation of Superintendents House under DEM Historic Curatorship Program

The WMSR Superintendents House is presently poised for rehabilitation through DEM's Historic Curatorship Program (see Section 5.4.2.4). Under this program, the Concord-Assabet Family and Adolescent Services Inc. (CAFAS), a non-profit social services organization, was designated as curator/tenants in 1996. The property will be rehabilitated as a leadership and environmental education retreat facility for youths and families. As part of their public benefit, CAFAS will provide support to park staff to inventory hiking trail conditions on the reservation as well as perform regular trail maintenance.

3.4 Native American Context

Wachusett Mountain was, and continues to be, a place of special and focused importance to the Native American peoples of central Massachusetts and southern New England. As the highest elevation in the region it was a prominent geographical landscape feature within the traditional territory of the Nipmuc Nation; the name Nipmuc historically refers to peoples living between the Merrimac, Blackstone, and Connecticut Rivers.

In the prehistoric past, and through subsequent historic periods, Wachusett Mountain served as a strategic location for gatherings of southern New England's indigenous peoples. The Nations and Tribes of the Wampanoags, Narragansetts, Penacooks, Pequots, and Massachusetts met here with Nipmucs to bind alliances, reinforce relationships, and for spiritual practices. In the mid-seventeenth century, during King Philip's War (1675-1676), it became a logistical focal point of Native American resistance to regional Colonial authority. The polarity between Native American and EuroAmerican cultures during the seventeenth century was reflected in their respective views of Mount Wachusett. It was a central place to Natives, each group recognizing its importance as a source of traditional power and a place for cultural and logistical fortification. To EuroAmericans it was remote, inaccessible, and a wild "monstrous mass". It would essentially remain that way in EuroAmerican eyes until the "Wilderness Movement" of the nineteenth century.

In 1676, with the death of King Philip and the end of large-scale Native American hostilities, EuroAmerican expansion into traditional tribal territories took place with relatively little Native American resistance. Many of the Indian peoples who had taken up arms against the Colonials, and some who had not, were sold into slavery, or imprisoned on Deer Island in Boston Harbor, where death was a certainty. Some small groups became refugees and were taken in by surrounding interior Indian Nations, while fewer still retreated to marginal lands around and within swamps, surviving in the shadows of increasing settlements. By 1681 however, twenty-two Nipmucs still occupying their territory petitioned the provincial courts to reclaim and resettle their ancestral lands. The General Courts ultimately pressed the Colony's rights to most of the Nipmuc lands, paying "some compensation" to the claimants. By the end of the seventeenth century, over 1000 square miles of former Nipmuc territory was part of the Bay Colony.

3.4.1 Archaeological Resources

Several archaeological sites listed within the site files of the Massachusetts Historical Commission (MHC) are reported on the slopes of the Wachusett Mountain. These sites have been reported by individuals and as a result of a recent cultural resource management survey of sections of the Mt. Wachusett Ski Area (Putnam et al 1995, 1998). A localized quartz chipping debris station (19-WR-598) was discovered by staff of Timelines, Inc. It consisted of ten pieces of debitage suggesting a small lithic workshop. Age and cultural affiliation of the small workshop could not be determined. Site 19-WR-345, was initially reported in 1983 (by Tonya Largy), and includes a lithic find spot consisting of a quartz flake and a blade, surrounded by several possible rock shelters. A large site (19-WR-20); a "village" reported by L.K. Gahan of the Massachusetts Archaeological Society was apparently discovered in 1940 and the site report filed by the Society in 1968. No temporal or cultural affiliation is indicted on the submitted site form. A recent survey of the summit (PAL in prep.) produced no evidence of archaeological sites.

3.5 Traditional Cultural Properties

The results of the 1995 Timelines, Inc. reconnaissance survey of the Wachusett Mountain Ski Area indicate that contemporary Native Americans in the region continue to recognize and utilize the mountain as a sacred place (Putnam et al 1995). Informant interviews with Kathy "Mother Eagle" Leone, and Chief Walter Vickers and Conrad Leister of the Nipmuc Tribe affirm the importance of Wachusett Mountain to Native American groups. In addition, archaeological evidence reported by Curtiss Hoffman indicates that the mountain is the location of ongoing ceremonial activity.

Together, the archaeological site information, the results of informant interviews with Native Americans and individuals familiar with the mountain, and the historical record combine to indicate the past and present importance of Wachusett Mountain to the indigenous peoples of Massachusetts. Sufficient data are available to indicate that Wachusett Mountain, being a place where contemporary Native Americans have conducted, and continue to conduct ceremonies rooted in their cultural ideologies, is a perceived sacred place and constitutes a traditional cultural property.

SECTION 4.0

Recreational Resources

4.0 RECREATIONAL RESOURCES

4.1 Background

The enabling legislation which created Wachusett Mountain State Reservation [Enabling Acts of 1899, Chapter 378] set out the basic purpose to "provide a fitting and creditable public park for the free use of its inhabitants"[1]. In response to changes in trends in recreational use patterns over nearly a century, efforts have been made by the various management entities (initially the Worcester County Commissioners, followed by the Department of Natural Resources, to the present-day authority of DEM) to provide public outdoor recreational opportunities to all citizens.

The Reservation began admitting automobile traffic in 1907. Major road reconstruction occurred during the 1920s, as sightseeing excursions by motorcar became increasingly popular. In 1933, the Balance Rock Ski Trail was established, as the sport of alpine skiing swept across America. The Worcester County Commissioners subsequently responded to the increased demand for skiing by constructing an expanded network of ski trails and installing two T-bar lifts in 1962. DEM has continued to accommodate steadily increasingly demand for vehicular sightseeing and skiing, as well as having established an extensive network of hiking trails and auxiliary facilities.

Along with its obligation to provide the public with a variety of recreational activities, however, DEM is keenly cognizant of its responsibility toward the protection of natural and cultural resources. Accordingly, DEM tailors its recreational facilities and operations in a manner which attempts to fulfill public recreational demand to the greatest extent possible, while respecting the natural and cultural resources inherent to a particular location. For instance, the geographic overlap between WMSR and the City of Fitchburg's public water supply watershed has been a major factor in determining the types of activities allowed within WMSR and land management practices associated with such activities.

A discussion follows describing the current availability of a range of recreational activities and supporting facilities. Further, under the recommendations of this RMPP, DEM will continue to manage the reservation for a variety of purposes, however the Department recognizes that increased use of WMSR potentially threatens the availability of passive recreational use and management of sensitive natural resources. Section 6 describes DEM's strategy for multi-use management of recreational resources within WMSR.

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[1] Wachusett Mountain State Reservation Commission, First Annual Report. January, 1901. Wright & Potter Printing Co., Boston.

4.1.1 Allowed Uses

Outdoor recreational uses that are currently allowed within WMSR include hiking, sightseeing, alpine skiing, cross-country skiing, snowshoeing, picnicking, walking, bird watching, general nature appreciation, mountain bicycling and horseback riding (both on designated trails only), fishing and hunting in season.

4.1.2 Prohibited Uses

Certain recreational activities are expressly prohibited within WMSR. Rationale behind the prohibition of these activities include public safety, potential impact to natural and cultural resources of the Reservation, and potential degradation of Fitchburg's public drinking water supply and watersheds serving metropolitan Boston, and .

Prohibited activities within WMSR include camping, swimming, hiking on ski trails, water slides, use of motorized recreational vehicles (e.g., snowmobiles, ATVs), use of roller skates, roller blades and skateboards, hang-gliding, metal detecting, artifact collecting, plant collecting, and archaeological or other scientific research without a permit from DEM[2].

4.2 DEM Developed Facilities

The Department of Environmental Management has developed and maintains the following facilities to support recreational uses within WMSR.

4.2.1 Visitors' Center / Administration Complex

The WMSR Visitors' Center and Administration Complex is located at the eastern periphery of the Reservation, at the foot of the vehicular access road to the summit. The Visitors' Center and administration offices are located in an approximately 4000 s.f. building, which includes public restrooms, interpretive displays, offices, employee kitchen, heated garage/workshop and a radio room which serves as the DEM statewide control center. The Visitors' Center is open to the public from 9 AM until 4 PM every day except Christmas, New Year's Day and Thanksgiving.

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[2] It should be noted that DEM, in turn, will require that any other applicable permits be obtained from the appropriate entities, such as the State Archaeologist or the Natural Heritage and Endangered Species Program.

In addition to the main building, the complex also includes a twelve-stall garage, storage shed, and visitor contact station. Formal parking facilities include public parking for twenty cars at the main building, twenty spaces at the visitor contact station, and employee parking at the rear of the main building. Actual use of the parking areas often exceeds capacity, with visitors establishing informal parking spaces along the entrance roadway.

4.2.2 Summit

A number of constructed facilities are located on the summit to serve both the public and an array of communications equipment used by public agencies. Visitor facilities include the access roadway and two parking areas (in addition to random parking on the very summit), two vista observation platforms, a picnic area, a 'summit pond' which reportedly was developed in conjunction with a resort hotel constructed in the 1800's, and numerous trails connecting the summit with the Reservation–wide hiking trail network.

Communications equipment include several radio towers, a fire tower, several small masonry buildings (one of which, Parker Lodge, formerly served as a recreational shelter, but is currently sealed), propane tanks, and security chain link fencing surrounding several of the tower structures. The top of a ski lift is also located just downgradient of the summit.

The summit is a very popular destination for hikers, sightseers travelling by car, and bird-watchers. At present, there is little definition to pedestrian and vehicular circulation patterns, and conflicts between pedestrians, automobiles, and bird-watchers occasionally occur during certain times of the year. DEM hopes to implement summit improvements in the near future, which will include enhanced pedestrian facilities and interpretive displays, potential consolidation of communications equipment, and modifications to the existing roadway and parking system.

4.2.3 Trails

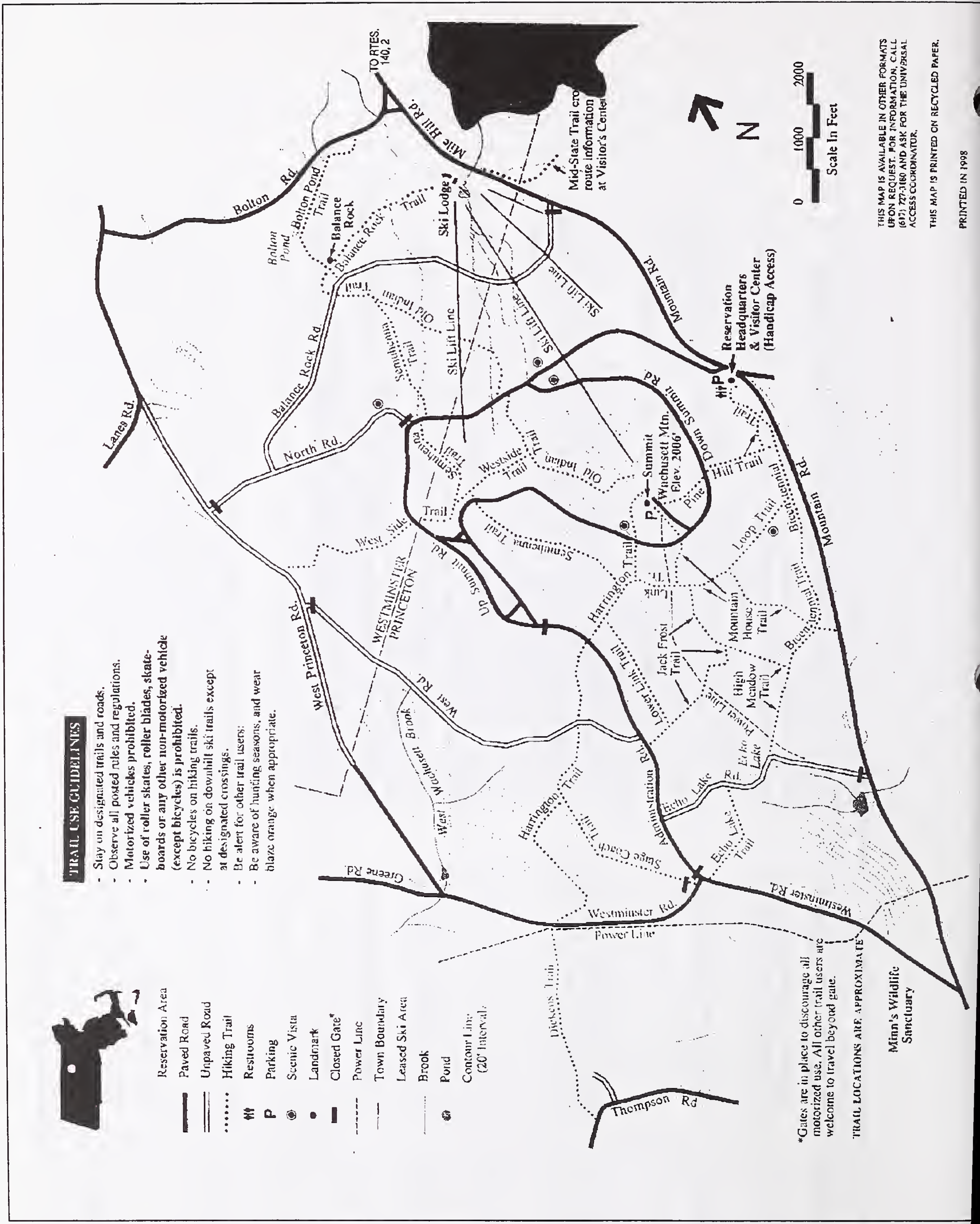
Wachusett Mountain State Reservation is traversed by 18 established hiking trails which total approximately 15 miles in length. Table 4-1 describes trails restricted to pedestrian traffic. In addition to the hiking trail network, several gravel roadways also cross the reservation, and are also used for hiking as well as cross-country skiing, horseback riding and mountain biking. These gravel roadways (described in Section 4.2.4) are periodically used by DEM personnel for maintenance activities, however they are not open for public vehicular use. Figure 4-1 is the official WMSR trail map, showing both hiking and vehicular access roads.

Table 4-1 Summary of WMSR Hiking Trails

Trail Name	Description	Comments
Balance Rock Trail	0.4 miles; 180 foot vertical rise; approx. 20 min hike	Parking for trailhead available at ski area complex (off-season); trail groomed for cross-country skiing; connects to Balance Rock Road, Sumehenna and Old Indian trails. Popular trailhead due to proximity to ski complex parking and amenities.
Bicentennial Trail	0.6 miles; 200′ rise; approx. one-hour hike	Traverses talus slopes on eastern side of Wachusett Mountain; difficult terrain though only minor vertical rise. Narrow footpath, well armored by large rocks; good condition.
Bolton Pond Trail	0.5 miles; 270′ rise; 30 min. hike	Trailhead parking on Bolton Road. Trail begins at Northern Red Oak Stand Representative Natural Area (see Section 2.4.5), parallels stream to Bolton Pond; leads to Balance Rock, a well-known glacial erratic..
Dickens Trail	0.8 miles; 45′ rise; 30 min. hike	Provides a connection between the Audubon Sanctuary and the Reservation. Rolling hills with a minor vertical rise.
Echo Lake Trail	0.5 miles; 80′ rise; 15 min. hike	Trailhead on Westminster Road. Gentle terrain through red spruce plantation adjacent to open meadow.
Harrington Trail	1.5 miles; 750′ rise; 1.5 hour hike	Provides link between Wachusett Meadows Audubon Sanctuary and Wachusett Mountain summit; part of Mid-State Trail network. Offers summit vista; beech woods; rolling hills, steep ascent toward summit.
High Meadow Trail	0.3 miles; 520′ rise; 20 min. hike	Trailhead on Mountain Road at terminus of Echo Lake Road. Passes through High Meadow, affording views of Little Wachusett Mountain; steep section beyond meadow. Generally good condition
Jack Frost Trail	1.5 miles; 600′ rise; 45 min. hike	Traverses steep areas supporting old growth hemlock stands; lower portion of trail known for mountain laurel display.
Link Trail	0.2 miles; 100′ rise; 10 min. hike	Short trail connecting Mountain House and Harrington trails on southwestern flanks of Summit. Traverses beech forest.
Loop Trail	0.6 miles; 300′ rise; 30 min. hike	Difficult terrain with steep talus slopes. Connects Bicentennial and Mountain House Trails to form a loop.
Lower Link Trail	0.6 miles; 68′ rise; 15 min. hike	Access via Jack Frost or Harrington Trails. Passes though stands of hardwood and hemlock; moderate terrain.

Table 4-1 Summary of WMSR Hiking Trails (continued)

Mid-State Trail	Approx. 4 miles through WMSR; continues to north and south	Includes sections of Balance Rock Trial, Old Indian, Semuhenna, West Side, Mountain House, Link, Harrington, and Dickens.
Mountain House Trail	1.1 miles; 740′ rise; 45 min. hike	Trailhead on Mountain Road. Provides access to Summit and Mountain House, passing through hardwood forest. Steep and rocky.
Old Indian Trail	1.5 miles; 750′ rise; 1.5 hours	Access from Balance Rock Trail or Road. Parking on Bolton Road. Steep, rocky terrain for majority of hike. Popular trail to ascend summit from ski area complex; closed during ski season due to ski trail crossings. Many sections of trail show evidence of compaction, erosion and unintentional widening.
Pine Hill Trail	0.75 miles; 600; rise; 25 min. hike	Very steep trail up to Summit, occasionally on exposed bedrock. Access from Mountain Road via Bicentennial Trail. As shortest trail to summit, combined with proximity to visitor center, Pine Hill trail is in very poor condition, with areas of significant erosion and wide swaths of compacted soil.
Semuhenna Trail	1.6 miles; 330′ rise; 45 min. hike	Roughly parallels Old Indian Trail at lower elevations, skirting summit. Moderate to steep terrain. Crosses Summit Roads and Balance Rock Road.
Stage Coach Trail	0.7 miles; 180′ rise; 20 min. hike	Trailhead on Westminster Road. Trail on wood roads and path, and includes hardwood forest, historic stone walls, and view of Princeton windmill farm. .
West Side Trail	1 mile; 410′ rise; 1.25 hour hike	Trailhead on West Princeton Road. Steep slopes west to Up Summit Road, more moderate slopes to east of Up Summit Road. Joins Old Indian Trail.



TRAIL USE GUIDELINES

- Stay on designated trails and roads.
- Observe all posted rules and regulations.
- **Motorized vehicles prohibited.**
- **Use of roller skates, roller blades, skateboards or any other non-motorized vehicle (except bicycles) is prohibited.**
- No bicycles on hiking trails.
- No hiking on downhill ski trails except at designated crossings.
- Be alert for other trail users.
- Be aware of hunting seasons, and wear blaze orange when appropriate.

*Gates are in place to discourage all motorized use. All other trail users are welcome to travel beyond gate.

TRAIL LOCATIONS ARE APPROXIMATE

THIS MAP IS AVAILABLE IN OTHER FORMATS UPON REQUEST. FOR INFORMATION, CALL (617) 727-3180 AND ASK FOR THE UNIVERSAL ACCESS COORDINATOR.

THIS MAP IS PRINTED ON RECYCLED PAPER.

PRINTED IN 1998

Figure 4-1 Wachusett Mountain State Reservation trail map

4.2.4 Vehicular Roadways and Parking

In addition to the public access provided by the hiking trail network, vehicular and bicycle access is also accommodated via a series of roadways. Several of these roadways are maintained for maintenance and fire prevention purposes, as discussed above, while only the Summit Road system (consisting of a combined network of one-way and two-way sections) is open to public vehicular travel. Though not open for motorized traffic, gravel access roads do, however, provide excellent bicycling and hiking opportunities..

Table 4-2 provides a summary of vehicular roadways within WMSR, including their present conditions and use guidelines. In addition to roadways, several parking areas are provided throughout the Reservation. These are summarized on Table 4-3, which identifies their current capacity and condition.

Table 4-2 Summary of WMSR Vehicular Roads and Parking Facilities

Name of Access Roadway	Description	Length (miles)	Comments
Summit Road	Two-way access road from visitor center to intersection of 'Up Road' and 'Down Road'	2.1 (incl. 2-way access to summit itself)	Closed between the end of October and Memorial Day weekend (varies depending upon conditions and staffing)
'Up Summit Road'	Asphalt roadway for one-way travel ascending Wachusett Mountain	1.0	Presently in poor to fair condition.
'Down Summit Road'	Asphalt roadway for one-way travel descending Wachusett Mountain	0.8	Fair top poor condition – scheduled for reconstruction
Administration Road	Sand and oil surface	1.1	Very badly deteriorated.
Balance Rock Road	Gravel	1.35	Good condition. Lower portion closed during ski season due to ski trail crossings.
North Road	Gravel	0.65	Good condition, with minor erosion at upper elevations. Offers vista of Mount Monadnock.
West Road	Gravel	1.1	Generally good condition, although dry laid retaining walls are beginning to deteriorate and will need to be reconstructed to prevent roadway collapse.
Echo Lake Road	Gravel	0.7	Good conditions with the exception of dam/earthen berm at Echo Lake, where erosion and overtopping are evident.

Table 4-3 Wachusett Mountain State Reservation Parking Facilities

Name of Parking Area	Location	Capacity (cars)	Comments
Visitors' Center and Contact Station	Visitors' Center complex off Mountain Road	40 designated spaces; 122 'informal' capacity	Designated spaces fill very quickly; cars park along perimeter of all designated spaces and along Summit access road
Summit	Summit	150-155	Sum of capacity provided by several parking areas scattered around summit; very poor condition and circulation patterns
Ledges Overlook	Up Summit Road	15 off-road; 15 roadside	Paved areas; very good condition
Lower Oxbow	Intersection of Up Summit Road and Down Summit Road	15	Parking area defined by trap rock/ timber wheel stops
Upper Oxbow	Down Summit Road (near Up Summit Road)	8	Paved area; birders frequently use area for tripod-mounted equipment, reducing capacity for vehicles
Bolton Pond Trailhead	Pull-off on north side of Bolton Road	5-7	Excellent condition (repaved in 1998); seasonally posted no parking in winter
North Road Trailhead	West Princeton Road	4 off-road; 5 roadside	Parking only available seasonally
North Road upper end	Intersection of North Road and Up Summit Road	6 off road	
West Side Trailhead	N/A	0	No parking at trailhead; visitors must use West Road parking area
West Road Trailhead	West Princeton Road	5-7	Seasonal off-road parking only
Harrington Trailhead	Roadside parking on Westminster Road	5-7	Informal parking along side of public road, not signed
Echo Lake Trail Administration Road/ Stage Coach Trailhead	Intersection of Westminster Road and Administration Road	8-10 off-road; 15 roadside	Fair to good condition; includes both paved and gravel areas
Echo Lake Road Trailhead	West side of Mountain Road	4 off-road; 15 roadside	Good condition; only roadside parking available in winter
Mountain House Trailhead	Roadside parking along Mountain Road	5-7	Informal parking on wide shoulder of public road
Balance Rock Road Trailhead	Mountain Road (east side)	2 roadside	Seasonal use only
Ski Area (Base Lodge)	Ski area complex (does not include satellite parking areas)	1100	Good condition; used primarily by visitors to ski area and maintained by WMA

4.3 Ski Area Complex

The ski area complex presently operated within WMSR is a leased to Wachusett Mountain Associates (WMA), a private, family-run business. Alpine skiing is believed to be have been introduced within WMSR in the 1920s, and historical records document that the Civilian Conservation Corps made improvements to Balance Rock Ski Trail and the established Pine Hill Ski Trail during the 1930s. Under stewardship of the Worcester County Commission in 1958, a proposal was made to formally establish downhill skiing facilities, including the clearing of new ski trails, the provision of lift equipment, and the excavation of a pond for snowmaking purposes. These improvements were implemented in 1962. As described in Section 1 of this document, stewardship authority of WMSR was transferred from the Worcester County Commission to the state by an act of the legislature in 1966, thus initiating the Commonwealth's involvement in the downhill ski industry.

Shortly thereafter, in 1968, the state sought bids from private operators to run the ski area under a five year lease agreement. Toward the end of this initial lease period, the state (then the Department of Natural Resources) funded a ski area master plan to assess the condition of ski area facilities and recommend improvements. Following completion of the Ski Oriented Master Plan (Sno-Engineering, 1973), it was determined that recommended expansion of the ski area should occur in phases. Given that then-Governor Francis Sargent had decreed in 1972 that no public funds should be expended for any ski area expansion, it was recognized that a long-term lease would be necessary to enable a private investor to recoup the cost of major capital improvements. Thus, in 1977, Chapter 287 of the Acts of 1977 gave DEM authorization to lease an area of 450 acres for further development of the ski area.

The present ski area lease allows for the management of the ski area and operation of ski trails, buildings and infrastructure related to the ski area facility. WMA also owns two satellite parking lots beyond WMSR boundaries, along with numerous other parcels abutting the Reservation, however these properties are not subject to DEM oversight.

While day-to-day operation of the ski area is the responsibility of WMA, there are several mechanisms for oversight of ski area operations. These include the following:

- ski area lease;
- public review of major capital improvements under the Massachusetts Environmental Protection Act (MEPA),
- recommendations of the Wachusett Mountain Advisory Council;

- review of construction activities by the Wachusett Monitoring Board;
- consistency of operations with the current management plan for WMSR (effective as of the 1999 RMPP);
- operator compliance with relevant local, state, and federal regulations.

4.3.1 Ski Area Structures

Facilities located within WMSR boundaries include a base lodge (which houses a restaurant, restrooms, ski equipment and accessories sales, day care center, and administrative offices), a ski rental building, ski patrol building, maintenance buildings for storage of snow making and grooming equipment, and five ski lifts. These facilities are described in detail in the Wachusett Mountain Ski Area Improvements Final Environmental Impact Report (EOEA No. 9690). WMA is seeking to enlarge its base lodge and add a sixth ski lift, as described in detail in the aforementioned FEIR document.

4.3.2 Ski Area Parking Facilities

The ski area operates four parking areas, with a current total capacity of 1630 cars. WMA is seeking to expand one of its parking lots which is beyond WMSR property boundaries in order to increase total parking capacity to 2005 vehicles. The largest of the WMA-operated parking areas on the Reservation is located adjacent to the base lodge, and has a capacity of 1100 vehicles. This parking area is also frequently used by visitors accessing the Reservation hiking trail network, via Balance Rock Trail, which originates to the northwest of the base lodge, or Balance Rock Road, located to the southeast of the base lodge.

4.3.3 Ski Trails

The ski area presently operates eighteen alpine ski trails. WMA has also proposed two additional trails under a recent FEIR. Due to concerns about potential erosion on the ski trails, no hiking is allowed along these un-forested corridors, although one hiking trail does traverse several alpine ski trails at an essentially perpendicular angle.

In addition to the downhill ski trails, WMA also assists DEM in maintaining a network of cross-country ski trails. These are largely located beyond the boundary of the ski area lease. WMA grooms trails which follow established gravel roadways, including Balance Rock Road, North Road, West Road, Administration Road, Echo Lake Road, and a portion of the Summit Road.

Grooming only occurs when sufficient natural snowfall has accumulated; cross-country trails are not supplemented by manufactured snow.

4.4 Recreational Demand

Wachusett Mountain State Reservation has experienced a significant increase in visitation over the past decade. Much of this may be attributed to population growth in general, augmented by the burgeoning popularity of active recreational pursuits. Section 1.4 provides a discussion of population trends in the vicinity of WMSR, while the present section focuses on recreational demand.

4.4.1 Statewide Comprehensive Outdoor Recreation Plan (SCORP)

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) is undertaken every five years, and involves an extensive public survey program. The SCORP program was established by the National Park Service in order to assist states in developing priorities for the enhancement of outdoor recreational facilities. The most recent SCORP survey was conducted in 1995, and projects demand for various recreational activities and facilities for the five year period between 1995 and 2000.

SCORP data provides an overview of statewide recreational patterns, and seeks to identify unmet needs for outdoor resources in order to establish priorities for funding of recreational facilities.

The statewide results of the 1995 SCORP survey identified four activities with the highest level of 'unmet needs' (i.e., activities for which the public believes there are inadequate facilities). These include road biking, swimming, walking, and playground activities. The next four activities mentioned are golfing, hiking, mountain biking, and tennis. Demand for hiking is mentioned more frequently by respondents from the Central region than in other parts of the state.

4.4.2 WMSR Attendance Figures

DEM and its predecessor DNR have maintained annual attendance records since 1969. These figures are reproduced in Table 4-4..

4.5 Linkages to Nearby Recreational Resources

Wachusett Mountain State Reservation provides not only a popular destination in and of itself, but serves an important role as a link among several surrounding open space resources. Management recommendations provided later in this document seek to strengthen ties between WMSR and nearby recreational lands.

Table 4-4 Public Attendance Figures for WMSR

Year	Reservation	Ski Area	Total
1900	Estimated seven month total		15,000
1969	111,287	14,000*	125,287
1970	101,292	16,000*	117,292
1971	122,495	15,000*	137,495
1972	129,263	17,000*	146,263
1973	138,247	20,000*	158,247
1974	132,373	15,000*	147,373
1975	143,276	33,176	176,452
1976	162,056	36,600	198,656
1977	209,563	43,180	252,743
1978	215,365	56,513	271,878
1979	223,586	38,315	261,901
1980	227,457	43,277	270,734
1981	251,109	78,997	330,106
1982	243,289	76,000	319,289
1983	262,943	253,657	516,600
1984	289,375	323,602	612,977
1985	262,900	360,000	622,900
1986	162,888	319,250	482,138
1987	282,134	495,000	777,134
1988	268,259	499,983	768,242
1989	228,877	355,450	584,327
1990	262,114	395,534	657,648
1991	263,707	265,639	529,346
1992	268,295	427,548	695,843
1993	274,313	525,561	799,874
1994	328,601	447,562	776,163
1995	360,840	368,798	729,638
1996	318,209	415,748	733,957
1997	359,416	372,018	731,434

*Estimated in 1985 GOALS Plan

Note: Due to the wide range of material used to obtain these figures, the most complete reports were used and are believed to be correct. These figures are believed to be fiscal year totals except for the year of 1900 which was a calendar year and a seven month total. Lease ski area totals include a 12 month total NOT totals for November through April.

Sources for attendance figures: 1901 Public Document # 65, pg. 15. 1985 G.O.A.L.S. Plan, Wachusett Mountain State Reservation, pg. 25; Annual Reports, Division of Forests & Parks, Fiscal Year 1985-1993; Wachusett Mountain State Reservation, Monthly Attendance Reports ; Letters from: Wachusett Mountain Associates, Joseph O'Brien, General Manager, James Crowley, President.

Linkages to nearby open space and protected land may serve ecological as well as recreational purposes. For instance, biological productivity is enhanced by continuity of unfragmented habitats and ecosystems, wherein certain wildlife or flora thrive. This greater diversity and/or concentration of natural resources in turn attracts visitors interested in nature appreciation as a recreational activity.

From an active recreational standpoint, linkages to nearby open space provide greater access and/or a greater variety of recreational activities than may be offered at a single location. In addition, visitors to WMSR may be directed to nearby open space as an alternative destination.

4.5.1 Nearby Open Space

WMSR is widely known for its extensive hiking trail network, alpine skiing in winter, driving for pleasure and vista viewing/sightseeing provided by its expansive summit views. Many visitors are drawn to WMSR because of this reputation, and may be unaware of alternative opportunities in the vicinity for hiking and general nature appreciation. This subsection introduces other protected lands within two miles of WMSR that are open to the public for enjoyment of natural resources. Figure 4-2 illustrates the proximity of the open space parcels discussed below in relationship to WMSR[3].

4.5.1.1 Leominster State Forest

Leominster State Forest, located approximately two miles to the northeast of WMSR, is a 4,126 acre parcel owned and managed by the Department of Environmental Management which straddles the town boundaries of Leominster, Princeton, Westminster, and Sterling. Leominster State Forest provides a wide variety of recreational opportunities, including hiking, swimming, non-motorized boating, cross-country skiing, snowmobiling, picnicking, rock climbing (with a permit) and scenic viewing from Crow Hill. Leominster State Forest provides a large block of largely intact forest habitat, several ponds and associated wetland resources, and is regularly utilized for silviculture. Leominster State Forest is open to the general public, and imposes a modest parking fee.

The Midstate Trail, discussed further under section 4.5.1.4, provides a direct link between Leominster Sate Forest and WMSR.

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[3] N.B.: "Other Open Space Land" as labeled on Figure 4-2 includes open space with these primary purposes: Recreation (facility based), Historical/Cultural, Water Supply Protection, Scenic, and Unknown as designated by MassGIS.

Figure 4-2

Proximity to Open Space

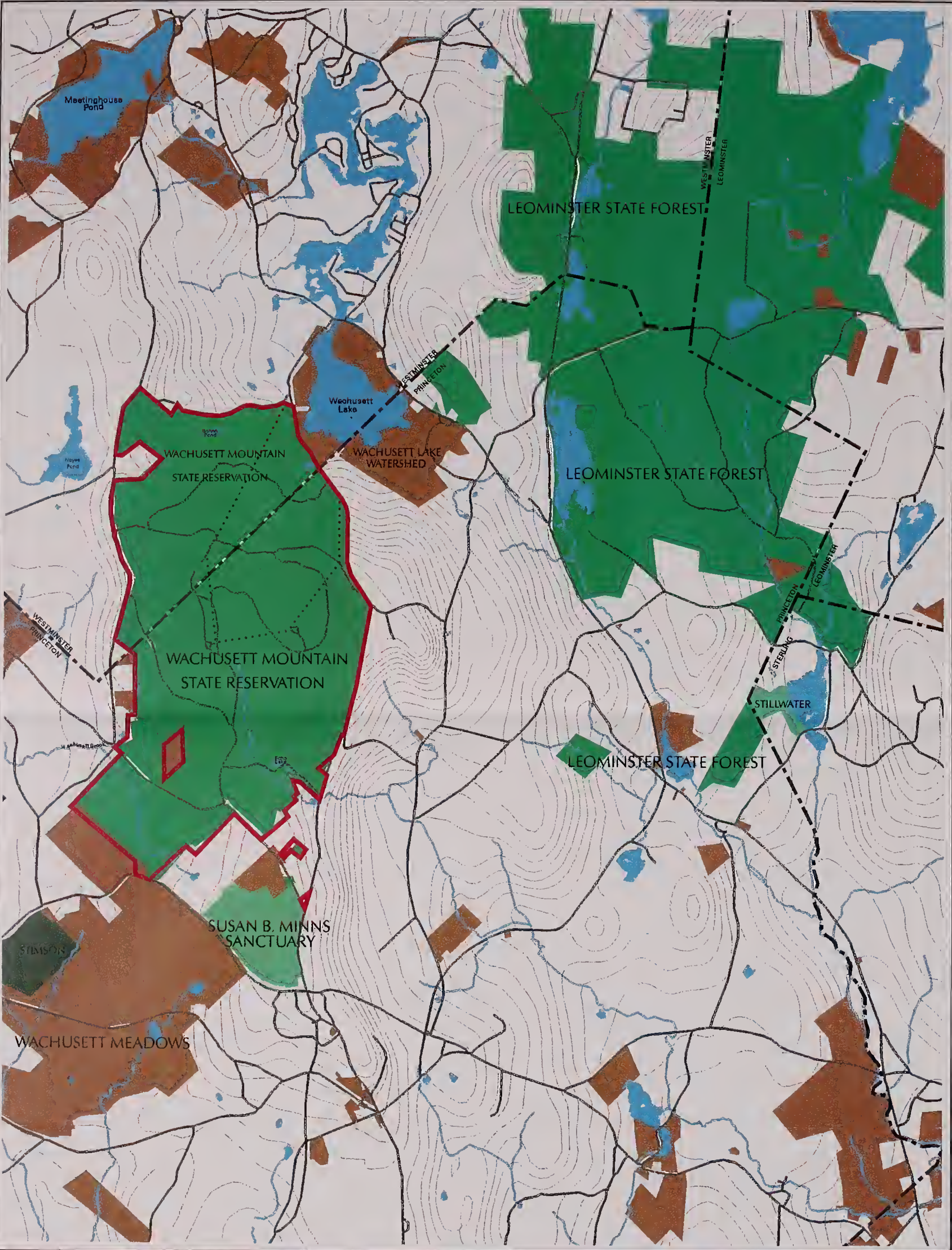

Figure 4-2 **Nearby Open Space and Protected Land**

Massachusetts Department of Environmental Management

Wachusett Mountain State Reservation
Resource Management and Protection Plan

Map Prepared By: Harvard Design & Mapping Co., Inc.

Base Data: 1998 MassGIS

4.5.1.2 Wachusett Meadow Wildlife Sanctuary

The Massachusetts Audubon Society (MAS) owns an approximately 1000 acre parcel known as the Wachusett Meadow Wildlife Sanctuary which directly abuts WMSR, sharing the southwestern boundary of the Reservation. Wachusett Meadow Wildlife Sanctuary has an extensive trail system, which is supplemented with interpretive signage to provide education to visitors about MAS efforts to manage certain types of habitat. A small fee is imposed for use of Wachusett Meadows Wildlife Sanctuary, unless a visitor has a current MAS membership. The Midstate Trail provides a direct connection to Wachusett Meadow Wildlife Sanctuary.

4.5.1.3 Minn's Wildlife Sanctuary

Minn's Wildlife Sanctuary is a 139 acre parcel which was bequeathed to the Massachusetts Department of Fisheries and Wildlife (MDFW), with the stipulation that the property is to remain a wildlife sanctuary in perpetuity. The MDFW property includes the summit of "Little Wachusett Mountain", located to the south of WMSR, and shares property boundaries with the Wachusett Meadows Wildlife Sanctuary. Foremost set aside for wildlife habitat, management of the property is limited to maintenance of existing trails.

4.5.1.4 Mid-State Trail

The Midstate Trail, as its name implies, crosses the middle of the state of Massachusetts, its end points being at the New Hampshire and Rhode Island state boundaries. As of the 1993 publication of the Midstate Trail Guide[4], the trail was approximately 93 miles in total length. The Midstate Trail commonly 'piggybacks' along other established trails as it crosses both public and private lands. Within WMSR, the Midstate Trail follows the alignment of Balance Rock Trail, southerly along Semuhenna Trail to its intersection with West Side Trail, easterly along West Side Trail to Old Indian Trail, thence across the summit of Wachusett Mountain, descends southerly along Harrington Trail to Westminster Road, where it joins Dickens Trail, which then exits WMSR property.

The Midstate Trail offers an important link between WMSR both to Leominster State Forest and to the Massachusetts Audubon Society's Wachusett Meadows Wildlife Sanctuary, as well as allowing hikers to continue to further points to the north and south. The Midstate Trail Committee sponsors an annual series of day hikes along the trail, and maintains the entire length of the trail through volunteer efforts.

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[4] Midstate Trail Committee – Worcester Chapter, Appalachian Mountain Club. 1993. Midstate Trail Guide.

SECTION 5.0

Management Resources

5.0 MANAGEMENT RESOURCES

5.1 WMSR Staffing

5.1.1 DEM Staff Assigned to WMSR

Present staffing of WMSR consists of six fulltime, year-round employees, supplemented by five seasonal laborers and a seasonal administrative assistant. Recommendations for additional staffing and reclassification of current positions is described in Section 6.

5.1.2 Wachusett Mountain Advisory Council

The Wachusett Mountain Advisory Council (WMAC) was organized in 1969 by the DEM. The WMAC was founded for the purpose of advising and assisting the Division of Forests and Parks in the fulfillment of its mission to conserve the natural resources and preserve the history of Wachusett Mountain, while providing opportunities for appropriate public outdoor recreational use of the Wachusett Mountain State Reservation. To accomplish this mandate, the WMAC acts as a two-way channel of communication between the Division's professional resource managers and the Reservation's user public. The WMAC continues to serve the dual mission of assisting the Division in fulfilling its broad conservation and recreation mandate and in acting as a channel of communication between the Division and the Reservation's user public.

The original WMAC consisted of ten members representing and appointed by the communities of Princeton, Westminster, Gardner, Fitchburg and Worcester. The five remaining appointments were made by the Commissioner of DEM upon the recommendation of the Director of the Division. The Department appointed members representing the Appalachian Mountain Club, a local ski area, and the Central Massachusetts Regional Planning Commission, as well as an outdoor writer/historian and an administrator. Since its original founding, additional members have been added representing the Massachusetts Audubon Society, the Nashua River Watershed Association, the Wyman Lake Association, the Wachusett Mountain Ski Area, the Montachusett Regional Planning Commission and an at-large member. Currently the WMAC has 15 active members.

The WMAC reports to DEM's Director of the Division of Forests and Parks. The Department's Region III office in Clinton serves to coordinate communication with the Director and provides limited administrative support to the WMAC. Although the WMAC has no statutory authority and its recommendations are non-binding upon the Department, the WMAC has been an effective advocate for the Reservation and an invaluable resource for the Department.

The Executive Committee of the WMAC consists of the Chairman, the Vice Chairman and the Recording Secretary. There are no standing sub-committees; however, the WMAC does periodically appoint committees to focus on certain projects. The WMAC appoints one of its members to serve on the Wachusett Mountain Monitoring Board, another advisory committee described further below.

Wachusett Mountain Advisory Council meetings are held quarterly, or more frequently, at the call of the Chairman. Meetings announcements are sent out by the Department to a broad mailing list and publicized in the local media. The public is encouraged to attend and voice their concerns and opinions.

5.1.3 Wachusett Mountain Monitoring Board

The role of the Wachusett Mountain Monitoring Board (hereafter, Monitoring Board) relates strictly to oversight of construction activities within the ski area, and more particularly upon monitoring of water quality downgradient of such construction (i.e., discharges destined for Wachusett Lake, a primary public water supply for the City of Fitchburg). The Monitoring Board was established in compliance with a condition of the 1980 Secretary's Certificate on the Draft Environmental Impact Report for the original proposal to expand the ski area. DEM subsequently appointed a five-member board to oversee those aspects of construction which involved erosion and sedimentation control, and which might thus affect water quality. This membership consists of one representative each from the City of Fitchburg, Town of Princeton, Town of Westminster, Wachusett Mountain Advisory Committee, and DEM. In 1993, the Nashua River Watershed Association requested representation on the Monitoring Board, bringing total membership to six.

The Monitoring Board meets on an 'as-needed' basis; that is, only in those instances when construction activities at the ski area are proposed which involve erosion and sedimentation control measures. There are no term limits established for Monitoring Board members.

5.2 Ski Area Lease Income

DEM receives income from the ski area through its lease agreement with Wachusett Mountain Associates. The lease agreement establishes two types of income to be derived from the ski area, one in the form of rent, and the second as a contribution toward a trust fund earmarked for land acquisition.

Annual rental income from the ski area is set at two percent of the gross revenues for the year. These monies are deposited into the state's General Fund, and are not directly available for DEM operations. However DEM's general budget is established through the General Fund, and the lease income therefore may indirectly benefit WMSR. The average rental income over the last several years has been $222,000.

5.2.1 Land Acquisition Fund

In addition to the rental income generated by the Wachusett Mountain Ski Area, Wachusett Mountain Associates also contributes one percent of its gross annual revenues toward a trust fund established specifically for land acquisition. The Land Acquisition Fund is primarily intended for purchase of conservation or recreational lands in the vicinity of WMSR, however DEM may also utilize these monies for other land purchases. Land Acquisition Fund monies may be utilized not only for purchase, but also for legal costs associated with appraisals, survey, closing and associated legal fees. The Land Acquisition Fund receives an average of $88,000 annually.

Table 5-1 below summarizes land purchases in the vicinity of WMSR, and identifies those that have been enabled through the Land Acquisition Fund, either in whole or in part.

Table 5-1 Property Acquisitions in the Vicinity of WMSR

Approx. Acreage	Land Owner
54.8	Massachusetts Audubon Society (formerly Porter)*
25.97	Krashes
13.04	Porter
211	Gates
3.62	Gates
0.49	Bancroft-Littlefield
44	Watson
8	Crowley
13.87	Beaman* (located near Leominster State Forest; intended to build link toward WMSR)
76	Estabrook*

* Purchase price funded in whole or in part though Land Acquisition Fund

5.3 Private Partnerships

5.3.1 Wachusett Mountain Associates

Wachusett Mountain Associates (WMA) is a family-owned company which has been operating the ski facility on Wachusett Mountain since 1969. In 1977, the state legislature authorized DEM to allow ski area operations to be expanded, turning construction and subsequent operation of the facility over to private hands under a competitive bid process. WMA was the successful bidder, and is operating under a 30-year lease with an option to extend for one to three 10-year additional periods. In addition to operation of the ski area itself, WMA also works cooperatively with DEM on matters where ski area operations overlap with overall stewardship of WMSR. As identified in Section 5.2.2, WMA also provides the state with rental income and contributes to a land acquisition fund which has been used to expand the Reservation land holdings.

5.3.2 Mid-State Trail Committee

The Midstate Trail Committee is a volunteer organization which maintains the Midstate Trail and runs an annual program of day hikes along the trail. The Midstate Trail Committee assumes maintenance responsibility for those trails within WMSR which the Midstate Trail 'piggybacks'. DEM has allowed the Midstate Trail Committee to undertake maintenance activities and lead hikes though WMSR on those trails designated as part of the Midstate Trail. Section 4.5.1.4 describes the Midstate Trail in greater detail.

5.3.3 Concord Assabet Family and Adolescent Services, Inc.

The Concord-Assabet Family and Adolescent Services Inc. (CAFAS), a non-profit social services organization, was selected as curator/tenant of the WMSR Superintendent's House in 1996. CAFAS will both rehabilitate the historic structure for use by the organization, and will additionally provide support to park staff by inventorying of hiking trail conditions and performing trail maintenance. The approximate amount of investment to rehabilitate the Superintendents House is $400,000.00.

5.4 Relevant Policies and Regulations

Many policies and regulations affect DEM's land stewardship operations, from the original legislation which conferred stewardship authority over WMSR to the state to guidelines issued by the agency itself and various state and federal regulations. Such directives play a pivotal role in management decisions related to day-to-day operations, capital improvement projects, and the design of resource monitoring efforts within WMSR. This section identifies policies and regulations which are relevant to DEM's stewardship of WMSR.

5.4.1 Stewardship Authority

As previously identified under Section 1.2.1, Wachusett Mountain State Reservation was originally established with the passage of the Enabling Acts of 1899, Chapter 378, to "provide a fitting and creditable public park for the free use of its inhabitants"[1]. Management of the reservation was subsequently transferred from the County of Worcester to the State's Department of Natural Resources (DNR) by the passage of the Acts of 1966, Chapter 658, and the DNR was later renamed the Department of Environmental Management (DEM). The passage of Chapter 287 of the Acts of 1977 gave DEM authorization to lease an area of 450 acres to a private entity for the development of a ski area.

5.4.2 DEM Policies and Programs

5.4.2.1 DEM Statewide Old Growth Policy

Subsequent to the discovery of Old Growth Forest on Wachusett Mountain, DEM created a statewide policy pertaining to any activities within areas of old growth on DEM property. DEM developed a policy in July of 1997, and made the draft policy available for public review through the Environmental Monitor and through DEM's internet web page. The initial draft was modified in response to numerous public comments, and was conditionally approved by the DEM Board on December 17, 1998, pending minor modifications. A copy of the most recent draft presented to the DEM Board is available in Appendix G.

DEM's statewide Old Growth Policy establishes its definition for old growth, sets forth the DEM goal to preserve and maintain the integrity of existing old growth stands, identifies the EOEA Land Stewardship Zoning System as a vehicle for 'restoration' of old growth characteristics, guides DEM personnel toward management of old growth attributes, and stipulates that site-specific management plans must be developed for each designated old growth area on DEM property.

In accordance with DEM's statewide Old Growth Policy and consultation with Harvard Forest ecologists, DEM has developed old growth management recommendations specific to WMSR (See Section 6.0).

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[1] Wachusett Mountain State Reservation Commission, First Annual Report. January, 1901. Wright & Potter Printing Co., Boston.

5.4.2.2 *Massachusetts Wildlands Program*

DEM has established a program which recognizes the value of properties which exhibit the Commonwealth's exemplary natural areas. "The Massachusetts Wildlands Program" recognizes two categories of lands, including "Backcountry Areas" and "Representative Natural Areas" (RNAs). Backcountry Areas are those properties which best represent Massachusetts "wilderness". These areas typically contain at least 150 acres of largely untouched natural resources, and are located in the most remote sections of DEM's forests, parks and reservations. RNAs are the habitats of exemplary biological communities and other uncommon plant associations.

One of the state's twelve designated RNAs, a northern red oak stand, is located within the northwestern portion of WMSR, and consideration is being given to recognizing the Administrative Limits of Old Growth Forest as another RNA.

5.4.2.3 *DEM Land Acquisition Strategy*

DEM's 5-Year Land Acquisition Strategy, dated 1997-2002, guides the department's statewide land acquisition decisions. This strategy, updating a previous report prepared in 1987, was developed in a process carried out by DEM land acquisition staff with input from all DEM employees and from regional environmental organizations and recreation interest groups. The strategy identifies eleven priority focus areas for land acquisition and protection which are organized into three subject areas:

Resource protection

- ♦ Greenways
- ♦ Representative Natural Communities
- ♦ Large Unfragmented Areas
- ♦ Coastal Resources
- ♦ Water Resource Protection
- ♦ Scenic Landscapes
- ♦ Historic Landscapes & Archaeological Resources

Recreation

- ♦ Bikeways
- ♦ Freshwater-based recreation
- ♦ Camping

Management/Enhancement

- ♦ Critical Adjacent Lands

As part of the preparation of this Resource Management and Protection Plan, the statewide strategy has been applied to Wachusett Mountain State Reservation. Recommendations related to land protection priorities for Wachusett are included in Chapter 6.

5.4.2.4 Historic Curatorship Program

The Historic Curatorship Program, administered by DEM's Office of Historic Resources, is an innovative leasing program designed to promote private support of historically significant public properties.

Under the program, DEM seeks to enter long term leases with private entities, referred to as "curator/tenants", in return for their investment in the rehabilitation, maintenance, and reuse of endangered historic properties located with the State's forests and parks. Twenty seven properties have been authorized by the legislature as suitable candidates for the program. Most properties are eligible for the National Register of Historic Places.

The process for selecting curator/tenants is open and competitive. For each property the process begins with the issuance of a Request for Proposals. Proposals are evaluated based on the applicant's reuse concept, approach to the rehabilitation of the property, implementation schedule, financial qualifications, experience and public benefit. Lease terms are determined by the amount of investment contributed towards the rehabilitation and long term stewardship of the property. On average, lease terms range between 25-30 years. At the end of the lease term, the property reverts back to the control of DEM.

To date, six properties are under agreement resulting in the commitment of approximately, $2.5 million worth of private investment in the rehabilitation of DEM-owned historic properties.

5.4.3 State Regulations

5.4.3.1 Massachusetts Environmental Policy Act Regulations

The governing regulations of the Massachusetts Environmental Policy Act (MEPA)(301 CMR 11.00) establish a public disclosure and review process for activities which have the potential to cause environmental impacts, and provide a framework for identifying mitigation measures to offset such impacts. Because WMSR is a state-owned property, MEPA review extends to all subject matter categories considered under the regulations, provided that a proposed project is large enough to trigger any single MEPA review threshold.

DEM presently has two infrastructure projects which will be reviewed under MEPA. The first project involves the repair of the existing 'Down Road', for which an Environmental Notification Form (ENF) was filed in May 1998. The Secretary of Environmental Affairs determined in the ENF Certificate that the reconstruction of the Down Road required the preparation of an Environmental Impact Report. The ENF Certificate further anticipates the second infrastructure improvement project DEM hopes to undertake, involving redesign of the summit circulation patterns and consolidation of communications towers.

5.4.3.2 Massachusetts Endangered Species Act

The Massachusetts Endangered Species Act (MESA – M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00) establishes procedures for listing and protecting rare species. Depending on their rarity, species may be listed as 'endangered', 'threatened' or of 'special concern'. For species that use wetland resource areas, MESA has overlapping jurisdiction with the state Wetlands Protection Act (see 5.3.4.5 below). In addition, all projects being reviewed under the MEPA process (see 5.4.3.1 above) are also reviewed for impacts to state-listed rare species pursuant to MESA.

Acknowledging the documented occurrence of several state-listed species within WMSR property, NHESP has been consulted during preparation of the present Resource Management and Protection Plan, and will be contacted prior to any proposed activities. A brief discussion of state-listed species is contained in Section 2 of this RMPP, and management recommendations are outlined in Section 6.

5.4.3.3 Water Resources Regulations

A substantial portion of the watershed to Wachusett Lake is derived from WMSR, a primary source of public drinking water for the City of Fitchburg; approximately 30% of the watershed is in the ski area itself.[2]

A smaller portion of WMSR ultimately drains to Wachusett Reservoir, however the Reservation is greater than five miles from this drinking water supply at its nearest point. Several state regulations govern activities which could impact public water supplies. These include the Massachusetts Drinking Water Regulations (310 CMR 22.00), Massachusetts Surface Water Quality Standards (314 CMR 4.00), and Watershed Protection Act Regulations (350 CMR 11.00).

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[2] Vanasse, Hangen Brustlin, inc. 1998. Wachusett Mountain Ski Area Improvements, Final Environmental Impact Report, EOEA No. 9690.

In addition to these statewide regulations, Chapter 32 of the Acts of 1984, passed by State legislature in May 1984, specifically allows the City of Fitchburg to sell raw water from Wachusett Lake to Wachusett Mountain Associates for snowmaking.

These statewide regulations primarily affect activities at the ski area, although portions of WMSR which are also within the watershed of Wachusett Lake include the two-way segment of the Summit Road, and portions of the 'Up Road' and 'Down Road'. Proposed activities within these areas are only indirectly affected by DEP water resources regulations.

5.4.3.4 Wetland Regulations

WMSR contains numerous wetland resources areas, including ponds, streams, and vegetated wetlands. These wetland resources are protected under the state Wetlands Protection Act (WPA) and its implementing regulations (310 CMR 10.00), and by the Section 401 Water Quality Certification Regulations (314 CMR 9.00), a federal wetlands protection program administered by the state. The WPA regulations are invoked if an activity has caused direct impact to a wetland, or is located within the 100 foot buffer zone of a wetland, as defined under state regulations. A Section 401 permit is typically issued automatically in conjunction with a WPA permit (i.e., and Order of Conditions).

5.4.3.5 State Legislation Pertinent to Telecommunications

Two Acts of the State Legislature have recently been passed with regard to telecommunications towers. These are Section 2A (2100-1961) of Chapter 205 of the Acts of 1996 and Section 110 of Chapter 88 of the Acts of 1997. Chapter 205 specifically allocates funding for a feasibility study of consolidating telecommunications equipment presently on the summit of Wachusett Mountain and introduces the possibility of private sector use of telecommunications equipment. Chapter 88 stipulates that any private use of telecommunications equipment on DEM property shall be leased for a maximum term of 15 years, and that lease conditions shall be "on such terms and conditions as said commissioner [of DEM] deems appropriate".

5.4.3.6 State Register of Historic Places

WMSR contains several structures and landscapes which are listed in the State Register of Historic Places. The State Register of Historic Places was created in 1982 to aid the Massachusetts Historic Commission (MHC) in the preservation of buildings, structures, objects, landscapes, archeological sites, and historic districts which may otherwise be threatened by new construction. The State

Register is a master list of properties designated as historic under several specific local, state, and federal statutes. In addition, the State Register establishes a comprehensive review process through which state governmental bodies may prevent damage to properties listed in the State Register.

5.4.4 Federal Regulations

5.4.4.1 Section 404 of the Clean Water Act

Section 404 of the Federal Clean Water Act defines jurisdiction over activities involving construction within wetlands which fall under federal definition. This program is administered by the U.S. Army Corps of Engineers (ACOE). The ACOE has established three general permit categories for the State of Massachusetts in recognition of the overlap between the Massachusetts WPA regulations and the 404 regulations, as follows:

- Category I: Automatic issuance of 404 permit in conjunction with a state permit for project involving fewer than 5000 sf wetlands impacts
- Category II: Screening level of review for activities which involve greater than 5000 sf of wetlands impacts, or for any amount of alteration to a wetland recognized under federal, but not state, definition
- Category III: Individual 404 review required for projects involving greater than one acre of wetland alteration

5.4.4.2 NPDES General Permit for Stormwater Discharge from Construction Activities

The National Pollution Dissemination Elimination System (NPDES) permit program includes provisions pertaining to stormwater discharges from construction sites involving greater than 5 acres of earth disturbance. The NPDES regulations, therefore, would be relevant to operation of WMSR only in the event that a proposed activity involves this degree of disturbance.

5.4.4.3 Section 704 of the Telecommunications Act of 1996

Section 704 of the Telecommunications Act of 1996 pertains to the placement of towers and other facilities necessary for providing personal wireless service. This law clarifies the authority of the federal, state, and local government in the siting of wireless service facilities by preserving local zoning authority within certain guidelines. The guidelines provide a framework for decision-making by zoning authorities regarding the construction, modification, and siting of towers and other facilities related to personal wireless service. This law will be relevant to WMSR if any siting of telecommunications towers or other facilities occurs within the Reservation.

5.4.4.4 Section 106 of the National Historic Preservation Act

This section of the National Historic Preservation Act of 1966 as Amended (16 USC 470 et seq.) requires agencies to consider the possible effects of their actions on historic properties, including districts, sites, buildings, structures, and objects included in and eligible for the National Register of Historic Places. Although agencies are not required to prevent possible adverse effects, they are required by the Advisory Council on Historic Preservation (ACHP) to consider possible impacts and to grant ACHP a reasonable comment period for actions which are expected to impact a historic property. This law will be relevant to WMSR if modification to the Summit or surrounding historic properties is made.

SECTION 6.0

Management Recommendations

6.0 MANAGEMENT RECOMMENDATIONS

6.1 Management Objectives

The overall mission of the Department of Environmental Management is to exercise care and oversight for the natural, cultural, and historic resources of the Commonwealth and to provide quality public recreational opportunities which are environmentally sound, affordable, and accessible to all citizens. Within the context of this overriding purpose, DEM has developed the following management objectives in specific consideration of the natural, cultural, and recreational resources provided by WMSR to assist DEM personnel in making management decisions in the day-to-day operation of the Reservation.

- Manage and protect the **natural resources** of the reservation to ensure a diverse and sustainable ecosystem. Recognize the importance and strengthen the connection of the Reservation to the surrounding landscape to enhance biodiversity and open space values.
- Maintain the high quality of **water** delivered by the watersheds of the Reservation
- Manage and protect the **cultural resources** of the Reservation, respecting the historical, spiritual, and symbolic importance of Wachusett Mountain to the region and the Commonwealth.
- Provide and maintain safe, enjoyable, diverse outdoor **recreation** opportunities, within the limits of the natural and cultural resources of the Reservation, focusing on appropriate mountain-based recreational activities. Maintain and enhance the scenic integrity of the Reservation as viewed both to and from the mountain.
- Provide public **education** and special events related to the natural and cultural resources and recreational heritage of the Reservation. Public programs and events should enhance protection and appreciation of the Reservation and include learning opportunities directed at families and children.

Wachusett Mountain offers a wide variety of recreational opportunities, ranging from skiing to "leaf-peeping". These activities have different land requirements and effect the environment in different ways. The role of DEM is to manage the Reservation such that a diversity of activities may occur in the area without unduly interfering with each other or with the natural and cultural resources present on the Reservation. Two essential strategies for the implementation of these objectives are appropriate land stewardship zoning and monitoring of resource indicators, which are detailed in Sections 6.2 and 6.3. Table 6-1 summarizes activities geared toward the realization of these management objectives.

6.2 Policy Recommendations

6.2.1 Application of Land Stewardship Zoning System

DEM applies a Land Stewardship Zoning System to its parks and reservations across the Commonwealth. This system provides a framework for the development of management guidelines geared toward protecting the particular resources located in different zones.

DEM's Land Stewardship Zoning process was piloted at WMSR in 1979. The zoning system was presented and described in the 1985 Guidelines for Operations and Land Stewardship (GOALS) plan for WMSR. In 1990, all EOEA agencies with land management responsibilities adopted a new zoning system modeled largely on DEM's GOALS zoning program. This system is intended to increase the consistency of management across all state-owned conservation land and improve interagency cooperation, especially in areas where two or more state agencies manage closely related properties.

The current EOEA zoning system used by DEM has three zones (in decreasing order of resource sensitivity): Environmental Protection, Conservation and Intensive Use. In addition, a 'significance overlay' can be applied to identify areas of the property that contain natural or cultural resources that are significant at the Federal, State, Regional or Local level. Where appropriate, detailed and specific management recommendations for these significant resource areas are spelled out in the management plan for that property.

By applying the Zoning Classification System Guidelines specifically tailored for each zone, activities within lands owned by EOEA agencies may be administered to ensure that sensitive and significant resources are recognized, and managed appropriately. The zoning system allows the land stewardship agency to guide development and improvements that accommodate public use into areas that can tolerate intensive use without substantial detriment to critical resources that may occur elsewhere on the property. If sensitive or significant resources are discovered after the zoning process has been applied to a property, the area may be rezoned for greater protection through an internal action by the land stewardship agency. Decreasing the protection level, however, requires review and approval by MEPA, the office that administers the

Table 6-1: Summary of Management Objective Implementation Strategies

Resource Category	Management Objective	Management Strategy	Reference Section(s)
Natural	Manage and protect the natural resources of the reservation to ensure a diverse and sustainable ecosystem. Recognize the importance and strengthen the connection of the Reservation to the surrounding landscape of biodiversity and open space.	◆ Establish appropriate Land Stewardship Zoning to facilitate protection and management strategies for natural resources	◆ Section 6.2
		◆ Continue to conduct baseline inventories; develop monitoring procedures for selected natural resources; define areas for silviculture	◆ Sections 6.2.1.6, 6.3.1, 6.3.2.1, 6.3.2.2, 6.3.2.3, 6.3.2.4
		◆ Implement land acquisition strategy for WMSR	◆ Section 6.2.2
		◆ Conduct comprehensive vernal pool inventory and develop measures to protect vernal pools	◆ Section 6.3.2.7
		◆ Identify location and extents of invasive species and implement appropriate control measures	◆ Sections 6.3.2.1, 6.2.3.5
	Maintain the high quality of water delivered by the watersheds of the Reservation.	◆ Monitor/ maintain recreational facilities and develop detailed stormwater management standards for construction activities	◆ Sections 6.3.2.2, 6.2.3.7
		◆ Establish baseline water quality of perennial streams and ponds	◆ Section 6.3.2.2
		◆ Modify water quality monitoring protocol for tributaries to Wachusett Lake originating from WMSR	◆ Section 6.3.2.2

continues on following page

Table 6-1: **Summary of Management Objective Implementation Strategies (cont.)**

Cultural	Manage and protect the cultural resources of the Reservation, respecting the historical, spiritual, and symbolic importance of Wachusett Mountain to the region and the Commonwealth.	◆ Establish appropriate Land Stewardship Zoning to acknowledge cultural resources	◆ Section 6.2
		◆ Inspect historic structures on annual basis; program repairs as necessary	◆ Sections 6.2.3, 6.4.2.1, 6.4.2.2
		◆ Upgrade summit facilities in accordance with historical significance and recreational needs	◆ Sections 6.2.3, 6.4.3
		◆ Monitor archaeological sites for signs of deterioration	◆ Section 6.2.3.2 and 6.3.2.8
Recreational	Provide and maintain safe, enjoyable, diverse outdoor recreation opportunities, within the limits of the natural and cultural resources of the Reservation, focusing on appropriate mountain-based recreational activities. Maintain and enhance the scenic integrity of the Reservation as viewed both to and from the mountain.	◆ Apply appropriate Land Stewardship Zoning to direct recreational activities within areas best suited to accommodate particular use	◆ Section 6.2
		◆ Develop monitoring procedures to ensure that recreational activities do not cause irreparable harm to sensitive natural resources	◆ Section 6.2.1.6, 6.3.2.1, 6.3.2.2, 6.3.2.3, 6.3.2.4, 6.3.2.7
		◆ Upgrade summit facilities and reconstruct Down Road	◆ Section 6.4.3
Educational	Provide public education and special events related to the natural and cultural resources and recreational heritage of the Reservation. Public programs and events should enhance protection and appreciation of the Reservation and include learning opportunities directed at families and children.	◆ Develop interpretive programs and educational literature	◆ Section 6.2.1.6 and 6.4.3.1
		◆ Implement policy to ensure that events programming respects site-specific attributes of WMSR	◆ Section 6.4.3.2

Massachusetts Environmental Policy Act. MEPA review involves public notification of the proposed activity (i.e., re-zoning), and provides a forum for consideration of the potential environmental consequences associated with that activity (e.g., the types or levels of activity that may be allowed if an area is rezoned for a higher level of use).

6.2.1.1 *Zoning Process*

The designation of land stewardship zones is based on the characteristics, sensitivity and significance of the natural, physical and cultural resources of a given area. To determine zones for a property, data on existing natural and cultural resource conditions are considered, including characteristics related to forestry, wildlife, vegetation, noteworthy and significant natural, cultural and historic features, hydrology, soils, geology, and recreational uses.

DEM's Land Stewardship Zoning General Use Guidelines provide an outline of the objectives and general management guidelines for each zone. The general use guidelines, which are applied throughout all properties managed by DEM, are reproduced in their entirety in Appendix H. A discussion of the application of these guidelines to WMSR follows.

6.2.1.2 *Zone Descriptions and Zone Classification System Guidelines*

In preparation of this plan, the following land use designations have been applied to particular portions of Wachusett Mountain State Reservation (Figure 6-1):

- **Environmental Protection Zone:** Highly sensitive areas requiring a high degree of protection, such as rare species habitats or fragile archeological sites, are within this zone.
- **Conservation Zone:** Areas in this zone are moderately sensitive, and may include those with managed woodlands, water resources, wildlife habitats, and agricultural resources. Opportunities for dispersed recreation are provided within this zone.
- **Intensive Use Zone:** Areas which can accommodate high levels of visitor use and associated structures or maintenance facilities, as well as areas where resources can best tolerate intensive use(s).
- **Significance Overlay:** Areas which contain certain resources that may be noted on federal, state, regional or local lists and registers. These 'significant' resources, which may occur within any one of the three zones described above, are identified under DEM's zoning system within a 'significance overlay'. Such resources will be

Figure 6-1 Land stewardship zoning

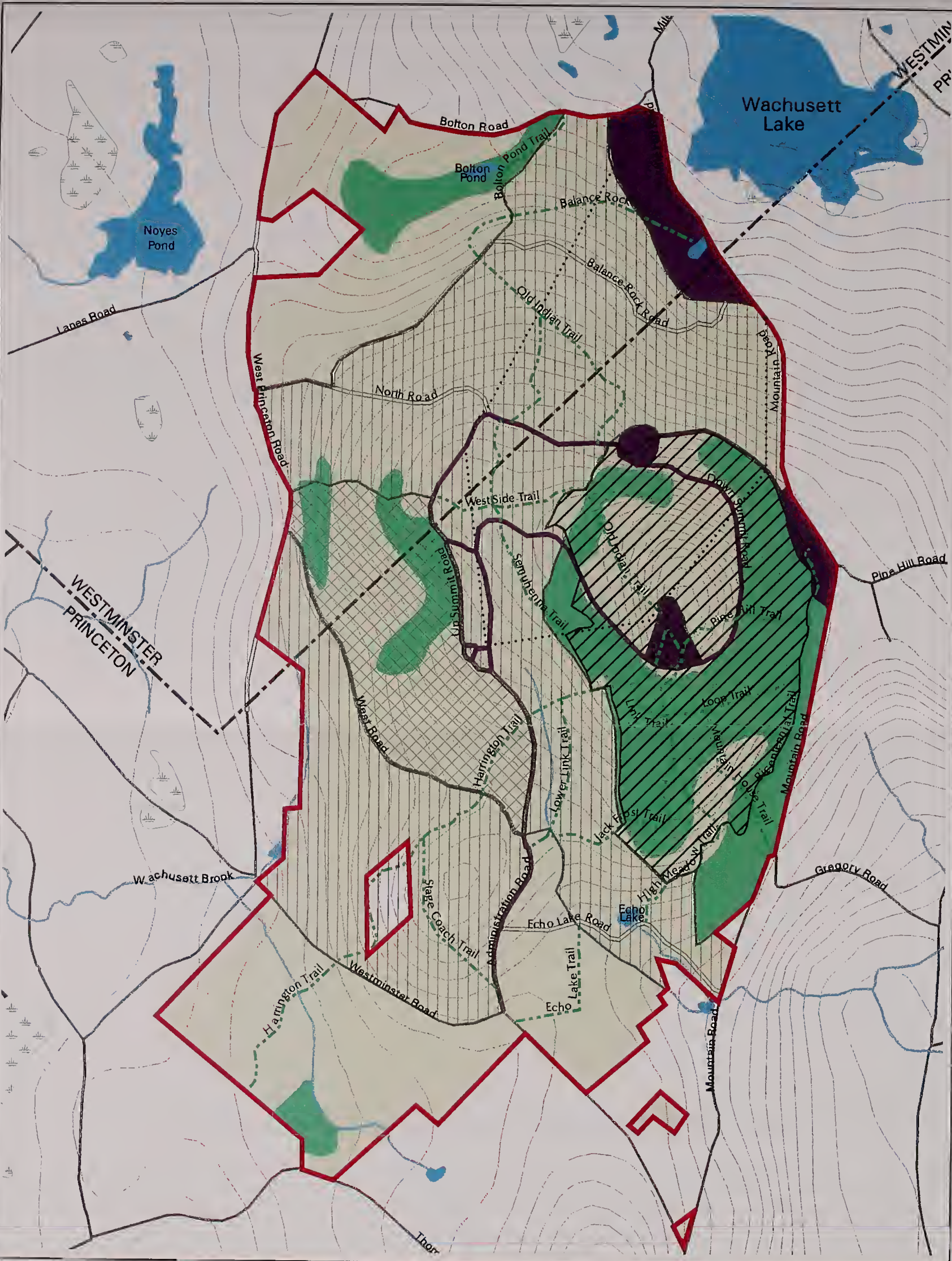

Figure 6-1

Land Stewardship Zoning

Massachusetts Department of Environmental Management

Wachusett Mountain State Reservation
Resource Management and Protection Plan

0 100 200 400 feet
0 40 80 160 meters

LEGEND

- Wachusett Mountain State Reservation Boundary
- Town Boundaries
- Paved Roads
- Unpaved Roads
- Trails
- 10 m Contours
- Hydrography
- Ski Lease Area
- Water Bodies
- Wetlands
- Old Growth Significance Overlay
- Eviornmental Protection Zone
- Conservation Zone
- Intensive Use Zone
- Interior Habitat Significance Overlay
- Biodiversity Significance Overlay
- Summit Natural and Cultural Significance Overlay

Map Prepared By: Harvard Design & Mapping Co., Inc.

NB: Trail locations are approximate.

Base Data: 1998 MassGIS

managed according to specific guidelines and recommendations from the listing agency (e.g., Natural Heritage and Endangered Species Program, Massachusetts Historical Commission) and/or as detailed within the management plan for that property. The significance overlay allows management activities to be tailored more specifically to the particular resource, and may be more restrictive that the Environmental Protection Zone.

Four Significance Overlays have been established at WMSR. One corresponds to the Administrative Limits of Old Growth Forest, buffered to the west by a second significance overlay established to protect interior forest habitat, a third overlay flanking the Old Growth area to the north and south which restricts future silviculture, and a fourth overlay recognizing the natural and cultural significance of the summit area. These Significance Overlays are described in further detail under Sections 6.2.1.6, 6.2.1.7, 6.2.1.8, and 6.2.1.9 respectively.

6.2.1.3 Environmental Protection Zone

The Environmental Protection Zone is the most restrictive category within DEM's statewide Land Stewardship Zoning system. It is only applied to those portions of a property which contain very sensitive resources which are highly vulnerable to human activity. This level of protection substantively restricts the types and levels of activity that are permissible within a given area, on the basis that certain activities may adversely impact the resources supported within that location. Within WMSR, the Environmental Protection Zone reflects the presence of very steep slopes (>30%), a wetland system in the northern portion of the reservation fed by springs and seeps, which partially overlaps a northern red oak stand designated by DEM as a Representative Natural Area, and a wetland in the southern section of the Reservation. Appendix H presents the complete list of general use guidelines for all portions of DEM properties designated under the Environmental Protection Zone, while certain guidelines are enumerated within the present text due to their particular relevance to WMSR.

The Environmental Protection Zone comprises approximately 350 acres of WMSR. These areas are encircled by areas designated as Conservation Zone, which provides some degree of buffer between these sensitive resources and areas of high activity. A notable exception to the symbiotic relationship between the Environmental Protection Zone and the Conservation Zone is the proximity of pre-existing roadways, which are categorized under the Intensive Use Zone.

Permissible activities under the general use guidelines which are particularly pertinent to the management of WMSR include cutting of vegetation to maintain or enhance vistas, vegetation management activities in association with habitat enhancement, and passage through the zone on existing stable roadbeds or trails.

Notably, no 'conventional' timber sales are allowed within the Environmental Protection Zone, although salvage operations are allowed. However, a large percentage of the Environmental Protection Zone is further protected by the application of a 'significance overlay' which acknowledges the presently documented extent of old growth forest within WMSR. This significance overlay, discussed further under Section 6.2.1.4, allows DEM to establish more stringent standards pertaining to silvicultural activities and vegetation management practices.

6.2.1.4 Conservation Zone

The Conservation Zone is extensively represented within WMSR, comprising approximately 1590 acres of the Reservation. The Conservation Zone recognizes the presence of natural and cultural resources which are moderately sensitive to human activities, and thus sets standards for uses consistent with DEM's mission to provide public recreational opportunities in concert with resource protection.

A comprehensive list of guidelines for areas within DEM properties designated to be a Conservation Zone is provided in Appendix H. Use guidelines which are most pertinent to WMSR include the provision for dispersed recreational opportunities, maintenance of scenic vistas and open fields, proactive efforts to diversify wildlife habitat, silvicultural practices, and development of small scale facilities such as gravel parking areas associated with trailheads.

6.2.1.5 Intensive Use Zone

Within WMSR, the Intensive Use Zone recognizes the presence and condition of certain facilities which currently accommodate large numbers of visitors and vehicular access. Intensive Use Zone general use guidelines are predominantly geared toward ensuring that adequate facilities may be developed and/or maintained without adverse impact to sensitive resources.

Those areas designated for intensive use coincide with portions of WMSR that have been historically altered, including portions of the summit, the Visitors Center complex, the ski area base lodge complex, and that portion of the summit roadway which is currently open to public vehicular use and its appurtenant roadside parking areas.

Given that these areas are subject to the highest level of activity and potential future development, the extents of each activity node has been definitively established, to prevent future incremental expansion of intensive uses and their infrastructure requirements. The boundaries of the aforementioned intensive use nodes are as follows:

- **Summit**: The summit of Wachusett Mountain has attracted visitors for well over a century, and draws crowds at various times of the year for bird watching, vista and foliage viewing, and general sight-seeing. This area has been extensively altered both under private ownership of the mountain in the nineteenth century, and at various intervals when efforts were undertaken to accommodate public visitation following the initial property acquisition which established the Reservation. While zoned for Intensive Use, a Natural and Cultural Resources Significance Overlay has also been assigned to the summit. The boundaries of the Summit Intensive Use Zone and the Natural and Cultural Significance Overlay are coincident, and include areas which are presently cleared, areas of scrub growth which are periodically cut to maintain open vistas, and an area of woodland bounded by the two-way summit access road, a segment of the Summit Up Road, and Harrington Trail. This wooded area has been investigated by Harvard Forest ecologists (see Appendix C), who determined that the area does not support Old Growth forest.

- **Visitors Center Complex**: The WMSR Visitors Center complex includes the Visitors Center building, Contact Station, 12-bay garage, materials storage yard, and affiliated parking areas. This area is relatively level, and well-defined by Mountain Road to the east and a steeply rising slope immediately to the west of the parking areas and summit roadway. The present northerly limits are similarly well-defined by the present configuration of the contact station parking lot. The southerly limits of this intensive use node are not readily identifiable in the field, extending approximately 1000 feet southerly of the Visitors Center. A portion of this area is used for storage of equipment and materials utilized for routine operations and maintenance of WSMR, while the remainder is young woodland. This intensive use area is characterized by very gentle topography.

- **Ski Area Base Complex**: The area surrounding the ski area base lodge is designated as an Intensive Use Zone. This area begins just south of the ski patrol building, running northerly to Bolton Road. The Ski Area Base Complex includes the base lodge itself, the main ski area parking lot, ski rental shop, maintenance buildings, and several ski lift bases. This intensive use zone extends approximately 650 feet (200 meters) westerly of and parallel to Mile Hill Road

- **Internal Roadways and Parking Areas**: The present extent of internal roadways and parking areas are zoned for intensive use, recognizing that these areas are able to accommodate high levels of activity. Acknowledgement of this intensive use zone allows DEM to concentrate public access within previously developed facilities, while discouraging access to other areas of the Reservation which are more vulnerable to human activity. This zone includes a strip within approximately 5 to 10 feet of areas of pavement or gravel, which must be maintained to ensure adequate drainage adjacent to paved and gravel surfaces.

6.2.1.6 Old Growth Significance Overlay

In recognition of the values inherent to old growth forest ecology, DEM has established an Old Growth Significance Overlay which corresponds to the Administrative Limits of Old Growth Forest ('Administrative Limits') established in consultation with Harvard Forest ecologists (see discussion under Section 2.4.1.1). This area has been designated as a significance overlay rather than under the Environmental Protection Zone because the Significance Overlay enables the application of site and resource-specific management strategies, whereas the Environmental Protection Zone simply adopts the 'blanket' guidelines for that zone, which are not specifically geared toward the protection of Old Growth. Further, in compliance with statewide DEM's Old Growth Policy (contained in Appendix G), DEM has developed several management recommendations specific to old growth forest within WMSR. These management recommendations seek to balance continued public access to the summit and other developed facilities within the Reservation while protecting the integrity of old growth resources.

The boundaries of this area follow prominent natural or man-made features so that they can be readily located on the ground. Within this area, a variety of age classes and ecological conditions exists - not every tree that occurs there is an old tree. However, a preponderance of the area is stocked with trees of advanced age and along with their younger associates they form a self-sustaining ecosystem. Within this area any potentially disruptive activities that might negatively effect the integrity of this ecosystem will be either prohibited or constrained to protect and maintain the integrity of this ecosystem.

The Old Growth Significance Overlay predominantly corresponds to the largest area of WMSR classified as an Environmental Protection Zone, although there is Old Growth in some areas of the Conservation Zone.. This Significance Overlay entirely encircles the summit of Wachusett Mountain, but does not overlap the intensive use zone on the summit itself in recognition of the long history of disturbance at this location.

DEM Statewide Old Growth Policy in Application to WMSR

The Administrative Limits include both the largest known stand and the most accessible area of old growth forest within the Commonwealth. The directives established under the DEM's statewide Old Growth Policy (see Appendix G) apply throughout that portion of WMSR designated under the Old Growth Significance Overlay. The following management protocols for WMSR have been established in compliance with the statewide Old Growth Policy in order to guide DEM personnel in day to day operation of WMSR:

Buffers

The establishment of site-specific buffers is called for under the statewide old growth policy. In effect, the Old Growth Significance Overlay incorporates a variable buffer by coincidence of using prominent features to define the boundaries of the Administrative Limits; i.e., in many instances, a 'built-in' buffer is provided simply because the nearest feature that is readily identifiable in the field may not be immediately adjacent to areas of old growth. At the same time, several pre-existing uses have coexisted either within or immediately adjacent to old growth forest within WMSR for several decades. The proximity of several pre-existing facilities – i.e., the Visitors Center complex, summit roadway, and uppermost ski trails, do not provide any opportunity for the establishment of a buffer to certain areas of old growth forest.

Where wooded areas are adjacent to a definitive Old Growth boundary, such as a stone wall or remains of barbed wire fencing, a buffer has been added to the definitive boundary to the nearest readily identifiable feature in the landscape (e.g., Summit Road). A minimum buffer of approximately 100 feet has been incorporated into the Administrative Limits boundary where the boundary of old growth forest is not readily identifiable, with greater buffers in many locations. Areas that have no clear edge assume either a natural boundary such as a streambed, or a man-made boundary such as a roadway or a trail. This management plan recommends further investigation of edge effects both adjacent to ski trails and the Visitors Center complex

Land Use Zoning

The zoning classifications under the present plan specifically acknowledge the extent of old growth forest at WMSR through the establishment of the Old Growth Significance Overlay, which supercedes the general land use guidelines for all the underlying land use categories.

Natural Disturbances

In the event of natural disturbances such as snow or ice damage, hurricane or tornado, insects or disease infestation, there will be no intervention to limit damage, unless there is immediate danger to public safety.

Fire

Fires will be extinguished as promptly as possible to protect public safety as warranted, however burned trees and coarse woody debris will not be removed.

Roadways

In accordance with guidance contained in the statewide Old Growth Policy, maintenance and passage along existing roads that pass through old-growth areas will be permitted but will be restricted to the existing corridor. Permissible maintenance includes maintenance of shoulder areas which are specifically designed to convey drainage (width varies between 2-15 feet from paved surface) and management of branches or brush which impede sight lines necessary for road safety (recognizing the combined use of the road for vehicles, bicyclists, and pedestrians). The condition of roadways should be monitored yearly and any necessary reconstruction or repairs should be undertaken in a manner which will preclude damage to adjacent old growth. Such precautions may include site-specific erosion and sedimentation control measures, leaving boles in lieu of cutting hazardous trees at ground level, and placing any brush and limbs that must be cut in association with construction or maintenance on the adjacent forest floor to mimic the natural deposition of coarse woody debris.

Hiking Trails

There are ten formally-designated hiking trails that traverse or skirt the Administrative Limits of Old Growth Forest. These trails will be maintained along their current alignment, and may be closed either partially or in their entirety during certain seasons to prevent hikers from straying from the trail to avoid muddy or icy conditions. Trails through the Administrative Limits presently range between 3-4 feet to 10-12 feet wide; efforts will be made to reduce the presently widest trails to a maximum of 6-8 feet; narrower trails will be maintained at their present width.

The trail height will be maintained at approximately 8 feet of clearance through selective pruning of intrusive branches when necessary, with cut limbs left on the forest floor to mimic the natural occurrence of coarse woody debris. Trail surfaces may include exposed bedrock or talus, placed stones in areas of barren soil on slopes prone to erosion, and the introduction of water bars consisting of rock or untreated timbers (i.e., sections of large limbs 'recycled' from trees occurring within the Reservation); trenching will be allowed to secure rocks or limbs used to deflect runoff. Water bars shall be inspected twice annually; once in the early summer preceding the most active use of trails, and again in late fall to ensure that trails will properly handle snow melt.

Vistas

There are several vistas within the Administrative Limits. They include the Harlow Outlook, the Oxbow, the Ledges, the Loop Trail vista, and the periphery of the summit. These vistas have historically been maintained to preserve viewsheds by periodically cutting vegetation. In recognition of this historical importance of views from Wachusett Mountain, DEM will continue to maintain existing vistas, and will restore a view corridor from Harlow Outlook. The presently existing vistas will be maintained by cutting vegetation saplings and brush in excess of six feet high. Although establishment of a vigorous shrub or groundcover is often recommended to discourage tree growth, DEM will not introduce any plant material to areas to be kept open for vistas, but will instead maintain naturally-occurring plant material through periodic cutting. The vista from the Harlow overlook will be restored to a narrow corridor by pruning selected limbs to establish a gap in the canopy. Creation of such a gap will mimic the structural equivalent of natural gap-forming events, and cut limbs will be left near the parent tree.

Ski Trails

Annual Work Plans

Work plans for maintenance of ski trails within the Administrative Limits will be submitted to the DEM Regional Director and the Wachusett Mountain Council by March 15th of each year for the following 12 months, in accordance with present policy for all construction, maintenance, and alterations at Wachusett Mountain Ski Area (contained in Appendix I).

Regeneration of Unauthorized Ski Trails:

Several unauthorized trails have been discovered through both areas of old growth and second growth forest. These trails have been quantified and documented by DEM personnel, including the lengths of the trails, average width, and number of stems cut along the length of each trail. Efforts to allow the trails to regenerate have since been undertaken, and initially consisted of modifying certain attributes of the illegal trails (e.g., reconstruction of stone walls where sections had been dismantled, removal of mats placed over stones, placing limbs across illegal trails to obscure visual signs of the trail alignment)

Natural regeneration of unauthorized trails will be monitored on an annual basis during summer months. Monitoring will include evidence of any continued use of trails and a comparison of herbaceous layer species composition within the area of the illegal trails as compared with an immediately adjacent area. Six sample plots will located; three within the 'footprint' of illegal trails, and three corresponding 'control' plots in undisturbed areas adjacent to the illegal trails. Sample and control plots will be selected by DEM personnel, and will be selected in order to reflect a range of community types which the illegal trails traverse. Plots will be 2 meters in width (roughly the maximum width of the documented illegal trails) by 10 meters in length. The inventory effort should be undertaken by DEM personnel with training in herbaceous species identification and standard vegetation survey procedures, with funding by Wachusett Management Associates.

Hazard Trees

A yearly inspection by WMA and DEM (prior to September 1) of trees along the ski slopes shall be made to determine if there are any hazardous trees that should be removed. It should be noted that this hazard tree identification policy has only recently been introduced, and that no trees have been cut adjacent to ski slopes for over ten years. The definition of a hazard tree is one whose crown is greater the 50% leafless (i.e., dead) and which, under natural conditions, would fall toward a ski slope. If it is likely that the tree would fall away from the ski slope and into the adjacent forested area, that tree will not be considered a hazard. An inventory will be completed identifying trees that have been or are scheduled to be felled, including species, diameter at breast height, condition of the tree, any additional comments and its location on the ski slope (name of trail and distance to nearest permanent feature).

A consistently maintained inventory of hazard trees and actions taken regarding hazard trees will provide a useful means of monitoring edge effects and will help to prevent the loss of forest acreage resulting from edge effects. The Park Supervisor, the Management Forester and the Forest Health Supervisor shall decide on the disposition of each potential hazard tree. Trees to be taken down in the Old Growth Area will be felled into the wooded area if possible adjacent to the trail and the top lopped so that it lies close to the ground. Trees leaning over a trail will be felled into the trail and cut up into manageable pieces and manually scattered in the adjacent wooded area. Downed branches and limbs occurring on ski trails shall be removed from the maintained area and carried into the nearest forested area (preferably proximate to the parent tree).

Existing Utilities

Electric lines, water lines, and lift lines that are presently located within the Administrative Limits may be maintained in operating condition, provided that such maintenance does not involve removal of vegetation. If replacement is proposed, preliminary specifications for site work shall be prepared by WMA and submitted first to the DEM Regional Director and then to the Wachusett Mountain Advisory Council and the Wachusett Area Monitoring Board as part of the annual work plan. If the preliminary specifications are approved, these will be further refined to identify construction and monitoring methodologies developed to ensure protection of old growth resources. No materials and equipment that are not actively utilized are allowed to remain within the Administrative Limits; procedures for removal of presently existing, defunct equipment will be detailed in the upcoming annual work plan for the ski area.

Public Education

Signage

Signage will be placed at all trailheads and at various locations on the summit identifying rules and regulations pertaining to activities within the Administrative Limits of Old Growth Forest. In addition, signs will be posted to indicate entrance into the Administrative Limits to reinforce the Reservation-wide rule to remain on designated trails. Signs will be placed on the edges of ski trails within the Administrative Limits of Old Growth and on some ski lift poles.

Special Permits

A Special Use Permit will be required for all groups engaged in activities specifically planned to take place within the Administrative Limits of Old Growth Forest. These permits are primarily intended to assign responsibility to an individual or group for the actions of the permittee, and will additionally be used by DEM to monitor the number and types of activities specifically necessitating access to old growth resources. This process will be implemented to ensure that proposed activities are undertaken in a manner that will neither directly not inadvertently impact old growth resources, assigns liability, and provides for the collection of information (and prevention of duplicating research) consistent with protocols of the scientific community. Such research may, at times, be kept confidential pending publication of findings.

Depending upon the nature of the proposed activity, Special Use Permits may be obtained just prior to the activity, or may be necessitate review and approval in advance of the activity. For uses which do not include any off-trail activity (e.g., an organized hike which plans to pass through areas of Old Growth staying on existing trails), a Special Use Permit may be obtained at the visitor center just prior to the activity. Organized groups which intend to leave existing trails for any reason must request a Special Permit in advance from the DEM regional office. Likewise, any proposal to conduct research in areas of Old Growth forest must obtain a Special Use Permit from the regional office outlining the proposed activity and schedule, and credentials in the instance of scientific research. No samples may be taken from materials occurring within areas of Old Growth unless specifically required for laboratory examination and approved under the Special Use Permit.

Interpretative Programs

There will be interpretive programs about the Old Growth by DEM personnel and by Special Permit for other groups. These programs will remain on the existing roadways and hiking trails that pass through this area.

The Administrative Limits of Old Growth Forest will be nominated for inclusion in the DEM's Wildlands Program as a Representative Natural Area. See Sections 2.4.4 and 5.4.2.2 for further discussion of this DEM program.

6.2.1.7 *Interior Forest Habitat Significance Overlay*

Recognizing the importance of forest resources within WMSR, including those which do not meet current definitions of Old Growth, a significance overlay has been established to protect interior forest habitat characteristics within that area of WMSR defined by North Road, Up Summit Road, West Road and West Princeton Road. This area is traversed by only one hiking trail (West Side Trail), and is characterized by rugged topography and a mix of hemlock and oak forest types. Due to the remoteness of this area and the prevalence of unfragmented woodlands, it is particularly valuable for species which prefer interior forest habitat. Stewardship activities within this significance overlay will be restricted to maintenance of West side trail at its present width (currently, this trail is in good condition, with no evidence of widening and little to no erosion); no additional recreational facilities will be developed within this area.

6.2.1.8 *Biodiversity Significance Overlay*

The biodiversity significance overlay provides an additional buffer to the northern and southern flanks of the Old Growth Significance overlay. The biodiversity significance overlay will allow continued use and maintenance of the numerous hiking and skiing trails within the limits of the overlay, including any necessary infrastructure improvements (e.g., dam reconstruction at Echo Lake and Everett Pool, annual ski area work plans). No commercial silvicultural activities will be allowed within the biodiversity significance overlay, however management of early successional vegetation will be undertaken to maintain scenic vistas, restore High Meadow to grassland, and to allow the continuation of the existing utility corridor, until such time that technological advances and financial feasibility enable its discontinuation.

6.2.1.9 *Summit Natural and Cultural Resources Significance Overlay*

The summit of Wachusett Mountain holds tremendous natural and cultural significance due to its topographical position and commanding vistas. It has attracted visitors for well over a century, and has earned the respect of indigenous peoples as a sacred place. The history of WMSR is in part a history of the summit itself, as much of the activity that has taken place within the Reservation has focused on the summit. Historical resources are still evident on the summit, including structures built by the Civilian Conservation Corps (CCC) and Works Progress Administration (WPA), as well as numerous etchings within areas of barren bedrock, once of which is an original survey mark for the first instrument land surveys undertaken for eastern Massachusetts in the mid-1800s.

A prior cultural reconnaissance survey determined that the summit area is eligible for listing in the National and State Registers of Historic Places, and further noted the significance of the area to Native American cultural practices.[1] Accordingly, DEM will undertake efforts to ensure that any activities (particularly physical improvements to the summit facilities) are designed in a manner which recognizes and honors the cultural significance of this area, and that the appropriate entities (e.g., the Massachusetts Historical Commission, Massachusetts Commission on Indian Affairs, and representatives of the Nipmuck Nation) are given the opportunity to review and comment upon any proposed alterations to the summit. In accordance with MGL Ch. 9, Section 26-27c, as amended by Chapter 254 of the Acts of 1988 (950 CMR 70-71), DEM will ensure that any physical improvements to summit facilities will be planned in coordination with MHC.

From a natural resources standpoint, the summit provides spectacular views of the surrounding landscape. Further, even in light of centuries of intensive use, the summit also supports an endangered plant species, which has survived in an area of high pedestrian traffic. Future management decisions regarding the use and physical improvements to the summit must be undertaken to sustain the viewshed which has drawn visitors to the peak, while also taking proper precautions to protect endangered species from either direct or inadvertent harm.

6.2.2 Land Acquisition Policy Recommendations

As in previous management plans for WMSR, DEM recognizes the desirability to continue land acquisition efforts in the vicinity of the Reservation. Such efforts are already bolstered by the existence of the Land Acquisition Fund (Section 5.2.2.1) and DEM's statewide land acquisition strategy (Section 5.4.2.2). Further, a land acquisition prioritization program has been developed for WMSR, which identifies potential land acquisitions that reflect management objectives for the Reservation. Previously, DEM had only targeted 'in-holdings' to augment WMSR, however the recently developed program considers and prioritizes acquisition of properties beyond WMSR boundaries.

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[1] Epsilon Associates, Inc. 1998. Natural and Cultural Resource Inventory and Analysis, Wachusett Mountain Summit. Report commissioned by the Massachusetts Department of Environmental Management. [Cultural resources reconnaissance survey undertaken by PAL of Pawtucket, RI.]

The key goals of the WMSR land acquisition strategy include:

- Extension of the western limits of WMSR in order to secure additional unfragmented interior forest habitat, and to provide limited passive recreational opportunities, including the protection of the scenic rural characteristics of West Princeton Road.

- Linkage between WMSR and Leominster State Forest, primarily to enhance recreational opportunities and to ensure public access along the Mid-State trail corridor, as well as providing a protected wildlife corridor between these two major land holdings. Establishing such a link will require assessment of the level of protection and public access already afforded much of the property between WMSR and Leominster State Forest, which is presently under ownership of the City of Fitchburg.

- Continued efforts to secure inholdings and properties immediately adjacent to WMSR along the southern extents of WMSR in order to protect a corridor to Minn's Wildlife Sanctuary.

Criteria to be considered as individual parcels are reviewed include the value of the land for protection of interior forest habitat, its location relative to establishing linkages to adjacent protected land, suitability of land for recreational purposes which are consistent with WMSR management objectives, cultural significance, and protection of viewsheds. Finally, the WMSR land acquisition strategy also seeks to work in partnership with the Massachusetts Audubon Society and the Division of Fisheries and Wildlife either to assist those entities or seek their support, depending upon the circumstances of the property under consideration.

6.2.3 Cultural Resources Policies

Wachusett Mountain State Reservation is an important cultural landscape containing a number of historically significant landscape features, standing structures and historic and prehistoric archaeological sites including the summit, old growth forest, a historic circulation and trail system, 19th century foundations, water features, stone walls, CCC and WPA-related structures as well as Native American sites. Many of these properties were identified as part of an initial study undertaken to develop a Cultural Resource Program for DEM (Roberts 1985). Additional surveys associated with the proposed expansion of the ski area (Putnam et al. 1995, 1998) and proposed improvements to the Summit and Down Road (PAL 1998) have added to this baseline inventory.

An additional resource that is increasingly coming to the forefront in preservation planning decisions is Traditional Cultural Properties. Traditional Cultural Properties are defined as significant places associated with cultural practices or beliefs of a living community that are rooted in the community's history and that are important in maintaining the continuing cultural identity of the community (Putnam et al. 1995:20). Sufficient data are available to indicate that Wachusett Mountain is a place where contemporary Native Americans have conducted, and continue to conduct ceremonies rooted in their cultural ideologies. As such Wachusett Mountain is a perceived sacred place and constitutes a Traditional Cultural Property.

6.2.3.1 General Management Recommendations for Cultural Resources

In 1984 and 1985, DEM undertook a study to produce a formal Cultural Resource Program for all of the properties under DEM's jurisdiction. This study resulted in a three-volume document, which identified 1) Threats to Archaeological and Historic Resources (Vol. I, Roberts 1984), Management Recommendations for Archaeological and Historic Resources (Vol. II, Roberts 1985a), and Guidelines for Interpreting Archaeological and Historic Resources (Vol. III, Roberts 1985b). In the Executive Summary, Roberts states that "It is not necessarily appropriate to save and protect every archaeological or historic site on Department lands. It is appropriate however, to manage every significant archaeological and historic site under the Department's jurisdiction. That is the key point in Cultural Resource Management" (Roberts 1985a:1).

Using Roberts' 1985 study as a base, DEM has implemented a number of procedures to insure the protection of cultural and archaeological properties. DEM's management of cultural resources, through its Office of Historic Resources (OHR) is based on current federal program as implemented through the Massachusetts Historical Commission (MHC). In accordance with M.G.L., Chapter 9, Section 26-27 as amended by Chapter 254, DEM is legally required to notify the MHC of any project that has the potential for impacting the historical, architectural, archaeological, or cultural qualities of a property. Should the DEM undertake a project under federal funding or requiring federal oversight and/or permits, Section 106 of the Historic Preservation Act of 1996 as amended (16 USC 470 et seq.) also requires consultation with the MHC.

DEM has implemented a general policy to provide for "the wise stewardship of all known and/or potential cultural and archaeological resources on DEM lands through appropriate resource management and planning."

The Office of Historic Resources (OHR) serves as DEM's liaison with the MHC. The OHR was established to provide preservation planning and technical assistance to all divisions within DEM. Furthermore, the OHR provides an ongoing program of inventory, survey, evaluation of cultural resources, and the nomination of resources to the State and National Registers of Historic Places. All divisions within DEM are to coordinate with the OHR on all projects that may affect known or potential cultural and archaeological resources.

The OHR is also responsible for efforts undertaken to expand and or supplement the baseline database. Additional data may include:

- more detailed information on known sites.
- location of new sites.
- sites threatened by adverse impacts.
- sites recommended for interpretive development or adaptive reuse.
- sites requiring mitigation strategies, location survey, site evaluation, or data recovery.

DEM procedures for protecting cultural resources include consideration of potential impacts to cultural resources early in planning stages. The baseline inventory is an important planning tool to utilize to avoid impacts to sensitive cultural resource areas. For every DEM project, a Project Notification Form (PNF) is prepared and the review and consultation process with MHC begins. To raise awareness and facilitate the review process, DEM has also implemented staff training through cooperation with MHC.

Policy/Procedure Directive #253, which sets forth the goals of DEM's approach to cultural resource management, has been revised by OHR and is under review. This revised policy directive is viewed as an initial step toward development of a programmatic Memorandum of Agreement (PMOA) between the OHR and the MHC. Through this PMOA, DEM and MHC will develop a formal, written agreement that will allow DEM some autonomy in managing cultural resources under its jurisdiction.

6.2.3.2 Specific Management Recommendations for Wachusett Mountain State Reservation

Nomination to the National Register of Historic Places

The Wachusett Mountain Summit Area is considered potentially eligible for listing in the National Register of Historic Places under criteria A and C. The Summit possesses significance under criterion A in the area of entertainment/recreation for its association with the development of the local tourism industry. Under Criterion C, the summit possesses significance in the area of landscape architecture. The placement of stone walls, lookouts, and picnic areas reflects a purposeful design that was meant to make the summit more attractive, and thereby increase public enjoyment of the area.

It is recommended that the Wachusett Mountain Summit be formally nominated to the National Register of Historic Places as a district. Such a district might include other resources, including the Up and Down roads, Harlow Overlook, Bullock Lodge, and the Superintendent's House, which are within the Reservation, but not part of the summit.

In contemporary anthropological terms the summit of Wachusett Mountain constitutes a Traditional Cultural Property, potentially eligible for listing in the National Register of Historic Places, which needs to be viewed in light of the American Indian Religious Freedom Act and Executive Order 13007.

Inventory and Evaluation

Much of the Wachusett Mountain State Reservation is undeveloped and potentially contains numerous prehistoric Native American and historic EuroAmerican archaeological sites. A baseline inventory has been established and is being added to as new surveys are conducted. However, many of the original properties in the inventory have not been confirmed. It is recommended that a cultural resource survey be conducted to confirm the existence of the properties on the baseline inventory and to collect additional data on these properties.

Furthermore, it is recommended that as a standard procedure the baseline inventory should be updated to meet MHC standards and submitted to the MHC for inclusion in Inventory of Historic and Archaeological Assets of the Commonwealth.

MHC Review and Consultation

In lieu of a formalized in-house program of inventory and evaluation of archaeological properties or a programmatic MOA, it is imperative that the DEM continue to coordinate with the MHC and afford the MHC the opportunity to comment on projects that may have the potential to impact archaeological properties.

Coordination with Native American Community

Coordination with the Massachusetts Commission on Indian Affairs is recommended to ensure guaranteed access to the summit of Wachusett Mountain, as well as other areas within the reservation, and to take into consideration the potential effect of any proposed undertaking upon locations within the reservation.

Current DEM policy on issues relating to Native American access and use of Wachusett Mountain, or any other Traditional Cultural Property is very informal. It is recommended that a more formal policy for coordination with Native American groups be developed subsequent to consultation with the Massachusetts Commission on Indian Affairs to ensure a long-term policy which will withstand changes in park administration over time.

Protection and Preservation of Cultural Landscapes

Planning for the preservation and management of the cultural landscape should be considered in the management of the reservation as a whole. Additional research and fieldwork should be conducted to identify areas of significance, assess physical change and evaluate the historic integrity of the landscape. All physical work undertaken at the reservation should be considered for its impacts to the cultural landscape as a whole and should be undertaken in a manner that protects its historic character. To promote responsible preservation and management of the resource, appropriate treatment should be applied to the landscape and its associated features (including buildings, structures, objects and sites) and should be consistent with the U.S. Secretary of the Interior's *Standards for the Treatment of Historic Properties* and the *Guidelines for the Treatment of Historic Landscapes.*

6.2.4 Educational and Interpretive Programming Recommendations

6.2.4.1 Interpretive Programming

DEM has recently increased the number of interpretive programs provided by WMSR staff, and plans to improve and rotate displays at the Visitors' Center. WMSR staff presently includes a year round and seasonal interpreter, whose responsibilities entail development of programs and brochures to increase visitors' understanding and appreciation of the natural, cultural and recreational opportunities provided by the Reservation. Interpretive programs are now held on a regular basis, and several specific recommendations have been made for potential interpretive displays on the summit in a separate report.[2] In addition to the present seasonal interpreter, it is further recommended that a staff ecologist (see Section 6.4.1.1) assist with development of interpretive materials and tours.

Additional interpretive programming will be implemented through the ski area, including an interpretive display within the base lodge, publication and circulation of the brochure "A View of the Great Hill", produced by WMA, and provision for expanded and updated interpretive displays should be incorporated into any improvements to the WMSR Visitor's Center.

6.2.4.2 Special Events Programming

WMSR is used by several groups for special events (e.g., the Eastern Massachusetts Hawk Watch and off-season programming at the ski area). Such events must be approved by DEM in order to ensure that events scheduling does not conflict with other activities within the reservation, and that DEM staff will be adequately prepared to handle the number of visitors anticipated to participate in the event.

In accordance with the management objectives previously set forth, special events held within WMSR should be consistent with the natural, cultural or recreational resources provided by the Reservation. Accordingly, specific guidelines have been developed for the programming and approval of special events held within the ski area, and are contained in Appendix I. These procedures seek to assure that such events will not negatively impact natural and cultural resources, nor the use and enjoyment of WMSR by the general public.

6.3 Land Stewardship Recommendations

6.3.1 Resource Indicators

In order to ensure that the land stewardship zoning system is fulfilling its intended purpose (i.e., directing activity levels to areas that can withstand the effects of such activities), DEM recognizes the need to monitor certain WMSR 'resource indicators'. Resource indicators provide a forewarning of stressful conditions, and signal that actions must be taken to avoid irreparable impact to certain resources. Resource indicators have been identified for each resource category considered in this document, including natural resources, cultural resources, and recreational resources. Further, management recommendations for resources are included where appropriate.

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[2] Ibid.

Resource indicators are selected based upon their ability to reflect ambient conditions, and are related to, but not the same as the resource itself. For purposes of the RMPP, parameters set by environmental regulations are employed as resource indicators in certain situations. However, in those instances where no set standards apply, DEM intends to establish baseline conditions and monitor changes to certain indicators to determine whether impacts are occurring to the selected resources. In order to effectively monitor resource indicators and review trends in the condition of such indicators, a staff ecologist position assigned to WMSR will be established. The primary responsibility of the ecologist will be to implement the monitoring programs recommended in this RMPP either in an oversight capacity or by directly undertaking specific activities, as appropriate. Further discussion of proposed staffing for WMSR, including the addition of a full-time ecologist position, is provided in Section 6.4.1.

Table 6-2 identifies the resource indicators within WMSR that have been selected for monitoring in 1999 and the parameter(s) that will be considered for each indicator. A more detailed explanation of each resource indicator and monitoring program follows under Section 6.3.2.

Table 6-2: Resource Indicators and Monitoring Parameters

Resource Category	Indicator	Monitoring Parameters
Natural Resources	♦ Old growth forest	♦ Bryophytes and spring ephemerals ♦ Edge effects
	♦ Water quality	♦ Water quality parameters for drinking water and fisheries
	♦ Species diversity	♦ Establish baseline inventories
	♦ State-listed species	♦ Continued occurrence of documented species
	♦ Invasive vegetation	♦ Extent of spread
	♦ Vernal pools	♦ Continued evidence of use
Cultural Resources	♦ Historical structures ♦ Archaeological sites	♦ Document resources in accordance with MHC procedures for listing in National and State Historical Registers ♦ Evidence of deterioration
Recreational Resources	♦ Trail conditions	♦ Width, erosion
	♦ Visitor experience	♦ User surveys

6.3.2 Monitoring Recommendations

6.3.2.1 Old Growth Forest

Although a great deal has been learned through this research, several gaps still exist in our knowledge of these areas. Recommendations for future research developed by ecologists from Harvard Forest includes the following:

- Use of GPS technology to precisely locate each plot examined on the mountain and to update the electronic version of the old-growth map. In addition, explicit directions to plot locations from well-established geographical points (e.g., trails, roads) should be stored at the Harvard Forest archives and at the Wachusett Mountain visitor's center. Access to this information will be subject to the Special Permit process for study of Old Growth forest resources (see Section 6.2.1.6 above).

- Follow-up re-sampling of permanent plots and other monitoring should take place at regular intervals to examine tree mortality levels and vegetation dynamics over time. Sampling of permanent plots should occur every five years, or more frequently in the event of any disturbances (e.g., observed or suspected insect infestations, such as hemlock wooly adelgid, or significant storm events).

- Future sampling objectives should include a more formal survey of community associations of flora in areas of old growth forest in the reservation, including bryophytes and spring ephemeral plants. In addition it would be useful to develop baseline information on wildlife populations within the old-growth areas.

- Additional areas within the original old-growth boundary that were only briefly examined should be intensively studied, such as the upper "islands" between ski trails, areas north beyond Harrington trail, the north slope red spruce stand, the southern slope above Echo Lake, and the area immediately south and southeast of the summit down to Down Summit Road.

In addition to the recommendations of Harvard Forest, DEM will also monitor evidence of 'edge effect' within areas of old growth forest. Edge effects often occur within the transition zone between one type of habitat and a distinctly different type of habitat (e.g., forest and meadow). Edge effects may have either beneficial or negative ecological repercussions. Beneficial effects include the diversity of species often associated with edge conditions, as this area provides an overlap between habitat types. However, some species show decline where edge conditions occur –for example, certain birds require large, unfragmented forest blocks for nesting, and some plants require deep shade or a relatively stable moisture regime found in deep woods. In addition, woodland edges often provide ideal conditions for the colonization of invasive species which rely upon birds for seed dispersal.

Accordingly , monitoring of potential edge effects will be undertaken adjacent to ski trails and at the WMSR visitor's center, where abrupt edges occur between Old Growth and cleared land. Specific parameters to be monitored include breeding birds and presence of invasive species.

6.3.2.2 . Water Quality

In order to maintain the high quality of water effected by WMSR, a water resources management program is recommended to include baseline analysis, on-going water quality monitoring and responsive/protective measures. This program should be developed and implemented through a joint effort of DEM, the City of Fitchburg, and Wachusett Mountain Associates (WMA) with input from DEP. The program should assist in characterizing water quality in WMSR and Wachusett Lake Reservoir and identify potential impacts to the water resources of WMSR and adjacent public water supply sources.

The following actions are recommended:

Baseline surveys

1. Complete a water quality baseline study of representative streams/brooks on WMSR to establish existing water quality levels.

2. Complete a baseline study of Wachusett Lake Reservoir in order to properly assess its present condition. Parameters to be considered should include, at the minimum, total organic carbon (TOC), biological oxygen demand (BOD), chemical oxygen demand (COD), and dissolved oxygen (DO). Water samples should also be taken for analysis of iron, manganese, phosphate, total sulfates, total dissolved aluminum, and nitrate concentrations. This sampling should be performed at several depths in the reservoir. The trophic state of the reservoir should be documented as well, and compared to previous records.

3. Conduct a sediment analysis at different depths in the delta of the tributary connecting Snow Making Pond to Wachusett Lake Reservoir to document the history of runoff into the reservoir, establish a current baseline to help assess past sedimentation patterns and conditions, and document any future changes in sedimentation and runoff.

On-going water quality monitoring

Institute an on-going water quality monitoring of representative streams and Wachusett Lake Reservoir to be conducted at regular intervals and of mutually agreed upon parameters.

Response and Protection Measures - Snow Making Pond Diversion

1. Under certain conditions, it may be necessary to protect water quality in Wachusett Lake Reservoir by diverting flow from the Snow Making Pond into Wyman Pond. DEM, WMA, and the City of Fitchburg, with input from DEP, will develop a protocol to govern the mechanics of such diversions. The protocol should include the following factors:

The water quality indicator to determine if diversion is necessary will be turbidity measurements in nephelometric turbidity units (NTU). Turbidity has been used to determine water quality in the past by DEM, WMA and the City of Fitchburg, and is deemed an effective indicator of general water quality.

Turbidity will be constantly monitored by a 24-hour turbidimeter. This will be used in conjunction with the monitoring program already established by DEM. A turbidimeter will be installed at the Snow Making Pond Dam upstream of Wachusett Lake Reservoir. In addition to regular turbidity monitoring, monitoring of Wachusett Lake Reservoir and the Snow Making Pond for the parameters included in the baseline study above is also recommended if any construction activities take place within that portion of WMSR which contribute to those water bodies.

2. After the results of the baseline survey have been analyzed, DEM, WMA and the City of Fitchburg, with input from DEP, will establish NTU values that will serve as triggers for paragraphs c. d., and e. below.

3. If water is flowing over the Snow Making Pond outlet spillway and the turbidity of a NTU level (to be established) is recorded at the Snow Making Pond outlet sampling station, a manual sample of turbidity will be taken by DEM. If the second turbidity reading exceeds a value (to be determined), the Fitchburg Water Division will be contacted and appropriate action will be taken to divert all water from the Snow Making Pond to Wyman Pond and to subsequently divert water back to Wachusett Lake Reservoir after turbidity monitoring levels have subsided.

4. During storm events, DEM will manually obtain additional turbidity samples at the outlet of Snow Making Pond.

5. If at any time the turbidity at the Snow Making Pond sampling station exceeds a NTU value (to be determined) for a seven day period, a sample will be collected from the outlet sampling station and analyzed by a State certified laboratory for alkalinity, chloride, color, conductance, iron, manganese, sodium, ammonia-nitrogen, nitrate-nitrogen, EPA Method 602, pH, total phosphorous, settable solids, suspended solids, turbidity and phytoplankton (enumeration and identification). DEM or the City of Fitchburg may initiate an inquiry to determine the source of the continued high readings. Additional sampling and testing, as well as diversion away from Wachusett Lake Reservoir may be requested at the discretion of the City of Fitchburg.

Sedimentation Ponds

An annual evaluation of sedimentation ponds will be performed in the months of April, May, or June. The evaluation will be performed on a specified date and representatives from WMA, DEM, and the City of Fitchburg will be invited to participate. WMA will prepare a report containing an assessment of each of the ponds, describing any actions which need to be taken to maintain water quality and retain the stormwater retention capacity, and submit the report to DEM, WMA, and the City of Fitchburg. Should remedial action be necessary, a written notification of timing and method of remediation will be made to the City of Fitchburg, and DEM, and appropriate filings made to the respective Conservation Commissions. This will include a plan for sediment/turbidity control and monitoring if sediment removal is necessary. During sediment removal the City of Fitchburg may require that outflow from the Snow Making Pond be diverted away from Wachusett Lake Reservoir toward Wyman Pond.

6.3.2.3 Species Diversity

Species diversity is a key indicator of the ecological health of a given location. Loss of diversity, and/or loss of a particular species, indicates that the habitat requirements of the species or suite of species has undergone change. Not all changes are attributable to human activity, as natural disasters (e.g., hurricane, drought, fire) may also cause a decrease in species diversity or loss of an individual species. Human activity may also have a beneficial effect upon species diversity, for example through management of open field conditions which are preferred by certain plant species and in turn by the many birds and insects which depend upon such plants for their life cycle requirements.

Present information on species diversity within WMSR is unevenly available and outdated records warrant field verification, particularly in regard to wildlife. Species inventories should be conducted (or collected and analyzed where extensive information exists, e.g., avian surveys) for each major faunal group.

The design of the inventory methodology should be developed in consultation with the Division of Fisheries and Wildlife. Field surveys should be conducted by knowledgeable persons, which may include professionals, academics, and amateur enthusiasts and volunteers with adequate training. Efforts should be made to compile information received from all such sources in order to maintain a current inventory. Inventories undertaken within the Administrative Limits of Old Growth Forest must be undertaken under the Special Permit procedure established for activities within this area. Information gathered to analyze potential edge effects within areas of old growth should be incorporated into the relevant species inventories.

6.3.2.4 State-listed Species

Monitoring efforts for state-listed species will be determined in consultation with the Natural Heritage and Endangered Species Program (NHESP). In that species requirements vary, a specific program will be developed for each state-listed plant and animal species on the official NHESP list of species documented to occur within WMSR. As part of the consultation with NHESP, DEM will determine an appropriate frequency of monitoring, time of year that monitoring will be undertaken, and persons to undertake such efforts (e.g., DEM personnel, consultant services, or knowledgeable volunteers). Documentation pertaining to state-listed species will summarize inventory procedures, species population estimates (where appropriate) and vigor of species.

6.3.2.5 Invasive Vegetation

As identified in Section 2.4.6, several invasive plant species have been identified within WMSR. The most aggressive of these non-native species include Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculata*), Morrow's honeysuckle (*Lonicera morrowii*), black locust (*Robinia pseudoacacia*), and multiflora rose (*Rosa multiflora*). At present, the density of invasive species at any given location is modest, and effective results may be reasonably achieved through physical removal of plants.

Immediate monitoring and management of these species is recommended as follows:

1.) Maintain a map at the WMSR visitor's center showing locations of invasive species identified to date.

2.) Instruct WMSR field personnel in identifying the species listed above in different seasons. A pictorial guide should be developed, showing typical growth habits (distant view), close-up photos of twigs and leaves,[3] and seasonal coloration, to assist field personnel in identifying invasive species at various times of year and from different vantage points.

3.) Inventory present extent of invasive species (e.g. stem count, approximate area, approximate height). This effort should preferably be scheduled when inventory efforts would be easiest to conduct (i.e., when particular species is readily distinguishable form surrounding vegetation; depending on species, this may be its 'leaf-off' condition, flowering period, or fall coloration). NHESP should be consulted in the event that invasive species are identified in the vicinity of any rare plant locations.

4.) Prioritize implementation of management/control measures, based upon which areas appear to have the greatest potential to spread. Factors to be considered include how the species spread (e.g., whether by seed dispersal, root sprout, clinging to /ascending nearby vegetation), proximity to documented locations of rare plants and the condition of the immediate vicinity (e.g., sunny, open or disturbed location versus shaded, interior woodland).

5.) Schedule implementation of control measures suited to species type and extent of stand. To the extent feasible, removal by hand will be the primary control measure. All invasive vegetation that has been cut and/or pulled should be removed to the visitor center maintenance area, and left to desiccate prior to being mulched or composted. Given several species' ability to spread through seed dispersal, locations from which species have been removed and stockpile areas should be inspected annually for seedlings. Seedlings should be hand pulled before the plants are able to develop extensive root systems and/or set seed.

In addition to the steps identified above, ongoing monitoring and management should include annual inspection of locations previously known to have supported invasive species, and along forest edges (e.g., along both public and interior roadways, ski trails, and transitions between open areas (fields, parking

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[3] "A Guide to Invasive Plants in Massachusetts", published by the Massachusetts Division of Fisheries and Wildlife, provides a useful starting point, and should be supplemented by distant views of species and seasonal variations.

areas, etc.) and forest. Field personnel should note locations of invasive species on the map maintained at the visitor's center, followed by scheduling and implementation of necessary control efforts.

Selected sources of further information on invasive plant species management include the following:

- Massachusetts Division of Fisheries and Wildlife. 1998. A Guide to Invasive Plants in Massachusetts,
- Brooklyn Botanic Garden. *Invasive Plants: Weeds of the Global Garden* (excerpts available through web site: www.bbg.org)
- The Nature Conservancy (TNC), Connecticut Chapter. Invasive Plant Fact Sheets (accessible through TNC web site: tnc.org)
- Federal Interagency Committee for Management of Noxious and Exotic Weeds (eds.) Pulling Together: A National Strategy for Management of Invasive Plants." 2nd edition. 1998
- Westbrook, R. 1998. Invasive Plants, changing the landscape of America: Fact Book. Federal Interagency Committee for Management of Noxious and Exotic Weeds.

6.3.2.6 Vernal Pools

Documentation for four vernal pools within the limits of WMSR was submitted for formal certification during the spring of 1999. There are three additional locations which may support vernal pool species that should be inventoried in the spring of 2000.

The Natural Heritage and Endangered Species Program, through its comments on the draft RMPP, has recommended that timber harvesting be prohibited within 100 feet of vernal pools, as mature forest provides adult stage habitat for mole salamanders which breed in vernal pools. Accordingly, DEM retains a 100 foot buffer around both known and suspected vernal pools within any area scheduled for silvicultural activities, prior to allowing any timber harvesting.[4]

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[4] It should be noted that only certain areas of WMSR will be managed for silviculture. These areas are located in the northwest and southwest extents of WMSR. See Section 6.2.1 and Figure 6-1.

Further, annual monitoring of vernal pools should be conducted to confirm continued breeding activities and estimate population densities and species represented. Monitoring activities will include egg mass counts at a minimum, and should be supplemented with trapping of adults under NHESP permit. It should be noted that trapping data collected in the spring of 1998 revealed that large numbers of spotted salamanders are attempting to breed in the Summit Pond, however there appears to be a 100% mortality rate of eggs deposited in the pond due to predation by exotic goldfish. DEM is presently working in collaboration with DFW and NHESP to remove and relocate the exotic fish in order to enable the Summit Pond to function as a vernal pool.[5]

6.3.2.7 Inspection of Historical Structures

A thorough inspection of historical structures will be implemented on an annual basis in order to identify any signs of deterioration, including degradation due to age (such as failure of masonry or wooden materials) and acts of vandalism. Observation of these conditions may occur at any time of year, however efforts should be made to undertake inspections shortly after a rainfall event in instances where water damage may be a concern. These investigations can be performed by DEM cultural resources staff, or WMSR personnel with adequate training in structural inspections.

6.3.2.8 Inspection of Archaeological Sites

Archaeological sites may be vulnerable to a variety of activities, and efforts must be continued to protect such resources from impacts. Due to the sensitivity of archaeological sites, the location of known artifacts is not disclosed in the present document. In addition, there may be other locations within WMSR which contain culturally significant sites which have not been conclusively documented. DEM has made initial efforts to establish an open communication procedure with Native American representatives, in addition to any review processes associated with the Massachusetts Historical Commission. Annual inspection of known archaeological sites will be performed in concert with inspections of historical structures, and efforts will be made to address signs of deterioration.

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[5] For further discussion of trapping results and analysis, see Epsilon Associates, *op cit.*

6.3.2.9 Trail Conditions

With increased visitation, many of the existing trails indicate signs of over-use and/or lack of adequate maintenance, such as excessive compaction, trail widths in excess of four feet, and gully erosion resulting from stormwater runoff. These factors may adversely effect a number of natural resources, including ability of plant species to root and take up oxygen, water, and nutrients, direct loss of plant species due to trampling, and sediment transport to stream systems.

The Montreal Botanical Garden has devised a three-level monitoring plan for use in the Montreal Urban Community network of parks which provides a useful basis for a monitoring plan at WMSR, as summarized below.[6]

Level 1 In order to assess the effects of visitor use on the trails and surrounding natural resources, trails will be monitored on a regular basis. Baseline trail widths and heights will be measured along the narrowest and widest segments of trails, and notes pertaining to overall trail condition will be documented on an annual basis. The annual trail survey will be undertaken by DEM field personnel, and should be coordinated with the regular activities of the Midstate Trail Committee and the proposed volunteer efforts of the Concord-Assabet Family and Adolescent Services Inc. (CAFAS), a non-profit social services organization designated as curator/tenants of the WMSR Superintendent's House. This level of monitoring is intended to evaluate the risk of overuse and degradation of each trail. Parameters for evaluating the risk of degradation include trail surface, type of habitat along trail, and presence or absence of trail edging. In addition, signs of visitor overflow, such as trampling of vegetation or illegal trails will be noted. Based on these parameters, the susceptibility of the trail to degradation will be evaluated.

Level 2 Level 2 monitoring provides a means of evaluating the level of trail degradation on those trails where deteriorated conditions are documented by Level 1 monitoring. The Level 2 effort will include segment-specific measuring of trail width, notations identifying the presence of surface rocks, abundance of forest litter and visible roots, soil erosion, presence of bike/vehicle tracks, soil resistance, and plant cover, and overall assessment of the level of degradation for the trail segment under consideration. Monitoring efforts will subsequently be focused on those trails and/or portions of trails which are most sensitive or most degraded, in order to determine what actions are warranted to initially stabilize deterioration, and subsequently rehabilitate trail conditions. This effort should be undertaken by the proposed WMSR staff ecologist and park rangers.

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[6] Natural Areas Journal 17(4): 366-379, 1997.

Level 3 The third level of monitoring focuses on trails which traverse areas of high ecological value and receive pressure from visitors. Level 3 monitoring should be undertaken regardless of visible signs of deterioration, in order to protect the integrity of ecologically fragile areas. Transects will be established perpendicular to each side of the trail over its length and plant and tree composition will be recorded. Using records of species composition over time, changes in composition resulting from nearby trails will be assessed. If it appears that trails through sensitive areas are deteriorating, causes of such deterioration will be identified (e.g., erosion due to accumulated soil or organic matter in water bars, or trail widening due to muddy conditions), and actions will be developed to remedy deteriorated conditions. This efforts should be directed by the proposed WMSR staff ecologist in consultation with park rangers.

6.3.2.10 Visitor Experience

DEM periodically uses visitors surveys to assess the visitor experience of various DEM facilities. A variety of survey methodologies are used, including written surveys, soliciting comments through a 'suggestion box', and verbal communications between staff and visitors. Recommendations made through these means are reviewed by DEM managers, and are considered within the context of DEM's overall mission, feasibility of suggestions, and the management objectives for the particular property. DEM will continue to implement user surveys at WMSR as a means of monitoring visitor experience.

6.4 Management Recommendations

6.4.1 WMSR Staffing

6.4.1.1 DEM Staff Assigned to WMSR

In light of the proposed increased monitoring activities, expanded educational program and increased visitation that has been experienced at WMSR, present staffing at WMSR needs to be augmented, both through new positions and reclassification of existing positions. Table 6-4 indicates proposed staffing for WMSR.

6.4.1.2 Staff Training/ Guidance

WMSR supports several sensitive resources which may be vulnerable to human activities. Paradoxically, the public is often curious about these very resources, and may question DEM staff about the location and access to such resources (e.g., state-listed species, Native American artifacts or Traditional Cultural Properties). Under analogous circumstances with National Parks, the National

Park Service has developed employee guidance for responding to inquiries about specific resources. The level of information to be provided to DEM staff and subsequently to visitors will vary depending upon the sensitivity of the resources. Details concerning staff training and guidance will be developed internally and with the Wachusett Advisory Committee members, and in some instances will not be made available to the general public.

Table 6-3 Proposed DEM Staffing for WMSR

Proposed New Year-round Positions	**Duties**
Unit Supervisor for Wachusett complex, Forest and Parks Supervisor IV (Grade 20)	Provide overall supervision of WMSR and Leominster State Forest, and their satellite facilities. Lead supervisor for oversight of the ski area and its lease. Liaison for matters pertaining to environmental issues affecting host communities and agencies with jurisdiction relating to WMSR and Leominster State Forest
Staff to Unit Supervisor Ranger I (Grade 14)	Provide law and policy enforcement and patrol for the ski area, WMSR and Leominster State Forest (Crow Hill Ledges). Control potential impacts generated on DEM property located within public supply watersheds
Ecologist (Environmental Analyst II)	Implement natural resource monitoring recommendations, assist seasonal interpreter with programming
Staff to Unit Supervisor Recreational Facilities Repairer (Grade 12)	Provide stop-gap repairs within the complex
Laborer II (Grade 10)	Provide coverage of the Visitor's Center on both regular and as-needed basis to maintain daytime coverage seven days a week
Proposed New Seasonal Positions	
Forest & Parks Supervisor I (Grade 14)	Backfill Recreational Facilities Supervisor II position that leaves the area from March to November
Laborer II (Grade 10)	Backfill Laborer II position that leaves the area from March to November. Would serve as trail crew.
Laborer II (Grade 10)	Backfill a current Laborer I position that leaves the area from April to November
Reclassification of Existing Positions	
Forest & Parks Supervisor II (Grade 16) to Forest & Parks Supervisor III (Grade 18)	Upgrade position and assign to Unit Supervisor to aid in the administration of the complex
Forest & Parks Supervisor I (Grade 14) to Forest & Parks Supervisor II (Grade 16)	Upgrade position to serve as the lead supervisor of WMSR and its satellite facilities
Interpreter (Grade 9) to Visitor Services Supervisor (Grade 15)	Serve as staff to the Unit Supervisor and oversee seasonal interpreter
Laborer I (Grade 9) to Laborer (Grade 10) 2 positions	Year-round laborers capable of providing coverage in the absence of a Supervisor
Typist II (Grade 8) Seasonal Position to Year-round position	Serve as staff to Unit Supervisor and as recording secretary to Wachusett Mountain Advisory Council and Monitoring Board

6.4.1.3 Wachusett Mountain Advisory Council

The Wachusett Mountain Advisory Council (WMAC), in accordance with its original purpose (see Section 5.1.2), provides a means of communication between the DEM's professional resource managers and the general public. The Council has been serving this role for three decades. In the context of this current Resource Management and Protection Plan, DEM and the Advisory Council has reexamined and formalized the role of the Council including responsibilities of members, composition of the Council, terms of membership, frequency of meetings, and establishment of subcommittees for particular projects (e.g., oversight of specific monitoring activities). Revisions to the composition, roles and terms of the Advisory Council have been initiated in collaboration with the present membership.

6.4.1.4 Wachusett Ski Area Monitoring Board

As discussed in Section 5.1.2, the present Monitoring Board was established in compliance with the 1980 Secretary's Certificate on the ski area expansion at that time. In 1994, after a period of inactivity[7], DEM reviewed the role of the Monitoring Board, and reactivated the role of the Monitoring Board in anticipation of the present proposal for ski area improvements. Specifically in response to the Draft EIR for the ski area improvements presently under MEPA review, DEM legal counsel determined "....it is anticipated that the Monitoring Board will remain in active status mode through the close of the second growing season subsequent to the completion of any construction that may occur as a result of the proposed facility expansion currently undergoing environmental review. Subsequent to that time, the board shall either again become inactive or retain intermittent status (perhaps an annual review)."[8]

6.4.2 Conform Lease Area to 1998 Survey

The 1977 legislation authorizing DEM to lease "...450 acres more or less..." for ski area development merely referenced "...a plan on file at DEM..." This plan was drawn up by DEM during consideration of the legislation to generally describe the lease area, but was not based upon an instrument survey.

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[7] The monitoring Board continued to provide oversight of ski area construction activities, however these activities were minor operations as compared with the level of construction which initially warranted the establishment of the Monitoring Board.

[8] Internal DEM memorandum dated 5/13/94

As part of DEM's effort to ensure accurate property data on Wachusett Mountain, DEM commissioned a survey of the ski area and adjoining reservation lands in 1998. The survey revealed that an area long used by WMA for ski lift operations actually fell outside the lease area described in the lease area plan developed by DEM at the time of passage of the authorizing legislation.

Given the long history of use by WMA, DEM believes that it is appropriate to have the legal arrangements between the Commonwealth and WMA reflect the longstanding usage. In the short term, DEM has provided a special use permit for WMA to continue its operation of the relevant acreage. In the longer term, pursuant to Article 97 of the Massachusetts Constitution, DEM and WMA will seek legislation to amend the authorizing legislation to conform current usage to the lease area.

6.4.3 Capital Improvement Recommendations

DEM regional staff have identified the following capital improvement projects to be undertaken consistent with the management objectives of the RMPP. Prioritization and funding of these projects will be reviewed annually in a joint discussions between DEM representatives in Boston, the regional headquarters staff, and WMSR personnel. The following listing does not reflect any prioritization.

- Repair/replace and improve drainage, walls, and road bed, and resurface approximately 4.0 miles of Auto Road to and from the summit and Down Summit Road
- Summit renovations including reconstruction of historic stone walls, drainage improvements, drain valve replacement in pond, pond cleaning, parking area relocation and/or resurfacing, radio systems consolidation, and development of interpretive displays
- Replace existing potable water system including well, pumps, storage tanks, pipe controls, valves, etc.
- Rehabilitate existing visitor's center heating system
- Upgrade existing septic holding tank to 5000-7000 gallon cap and/or enlarge sewer line or eliminate tank and enlarge sewer line for direct use
- Rehabilitate/replace existing exterior lighting system, including poles, ballast, switches, controls
- Reconstruct Echo Lake Dam and add control device or structure

- Repair drainage and road bed, and resurface Administration Road from Westminster Road to Summit Road

- Repair/regrade North Road, West Road, Balance Rock Road, and Echo Lake Road, including reconstruction of stone walls as necessary

- Rebuild and/or relocate trail sections to various trails within the system

- Relocate metal gates at Upper North Road and main entrance on Up Summit Road just beyond contact station, and on Balance Rock Road at Mountain Road to allow off-road parking

- Explore alternatives to overhead utility lines (e.g. underground alignment on Administration Road or solar panels)

- Repave and install drainage around Visitor Center and parking lot

- Inspect Bolton Pond and Everett Pool dams, add repairs to capital improvement program if necessary

6.4.4 Annual Reporting

DEM will conduct an annual review of the status of the proposed management recommendations. A brief summary report will be prepared and presented to the Wachusett Mountain Advisory Council and the general public in the late fall/early winter of each year beginning in the fall/winter of 1999. The scheduling of the annual status update is intended to enable findings of the previous seasons' field studies to be summarized.

SECTION 7.0

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APPENDIX A

Status of 1985 Goals Recommendations

STATUS OF 1985 GOALS PLAN RECOMMENDATIONS

A number of recommendations were presented in the 1985 GOALS management plan. Those recommendations are summarized below, by topic, followed by a description of the present status of each subject category.

Watershed Protection

Then, as now, the protection of the water quality of WMSR's watersheds was a primary DEM concern. DEM's recommendations called for a combination of daily turbidity monitoring until December 1, 1985, as well as an extension of the life of the Ski Area Monitoring Board for an indefinite period. In addition, DEM reaffirmed its commitment to achieving the optimum level of soil stabilization over the entire Reservation, through appropriate management and maintenance practices.

Present Status Subsequent to the publication of the 1985 GOALS plan, DEM determined that daily water turbidity monitoring at selected sites would continue for an indefinite period. To date, daily monitoring by DEM staff has continued without interruption. Since 1996, following a long period of relative inactivity, the Ski Area Monitoring Board has resumed an active role in reviewing Ski Area construction projects as required. With regard to soil stabilization, the Ski Area leasee maintains its ski trails in accordance with operational standards developed in concert with DEM. In addition, in 1996 Wachusett Mountain Associates (WMA) prepared a five year plan of Ski Area maintenance for projects subject to the Wetlands Protection Act. This plan was submitted to, and approved by, the Conservation Commissions of the Towns of Princeton and Westminster.

Public Access

The 1985 GOALS Plan called for maintaining and upgrading the existing road system within the WMSR as needed. It was also recommended that pubic vehicular access continue to be limited to portions of Administration Road and the Summit Road loop system.

Present status The DEM continues to maintain the gravel and paved road system of WMSR to acceptable standards, commensurate with available funding. Recent DEM plans to repair deteriorating segments of Administration Road and the "Down Road" were suspended by the Secretary of Environmental Affairs, pending the completion of this updated WMSR Management Plan. Public vehicular access continues to be limited to those segments of Administration Road and the Summit Road system which were accessible in 1985.

Sanitary Facilities

The only public sanitary facilities at WMSR are located at the Visitor Center/administration complex off Mountain Road in Princeton. In 1985, DEM acknowledged that the sanitary system of this building was inadequate to efficiently service the Reservation's users during peak recreation periods. Although the building is connected to a municipal sewerage system, water is supplied by an on-site artesian well. At certain times of the year, particularly in the fall foliage season, the public often encounters long lines of visitors waiting to use the building's restrooms. In addition, the well is occasionally unable to provide sufficient water and the restrooms have to be closed until the well can recover. For these reasons, DEM recommended that a second sanitary system be provided by converting the existing unused contact station for use as a restroom facility.

Present Status For the past several fall foliage seasons, DEM has provided portable toilets near the Visitor Center. This has helped to alleviate some of the problems, but creates its own set of issues with regard to security and maintenance of these units. The problems outlined above still exist and should be addressed as quickly as possible.

The Summit

Since the late 1800's, the summit of Wachusett Mountain has been a popular and heavily used scenic viewing site due to its elevation above the surrounding land. The summit is also a valuable site for the placement of communication systems for this reason. Unfortunately, decades of human use and the construction of numerous communications towers have resulted in a barren and unsightly mountain top. It has been a long-standing goal of DEM to eliminate public vehicular access to the Summit, (with the exception of limited handicapped vehicle access) as well as communications towers and other equipment to the greatest extent possible. The summit proper could then be developed as an attractive, safe pedestrian-only site.

Present Status Vehicle parking on the summit continues due to a lack of sufficient alternative parking capability. DEM remains committed to eliminating on-summit parking (excluding HP parking) as soon as adequate sub-summit parking capacity is provided. Several years ago, Phase I of a two phase project to develop sub-summit parking was completed, but Phase II did not go forward due to lack of funding. Phase I provided 29 parking spaces, with Phase II designed to provide 40± additional spaces. A conceptual summit landscape plan was prepared by DEM staff in 1994 and was reviewed and accepted by the Advisory Council.

DEM has been largely successful in holding the line on any further telecommunications development on the summit since the publication of the 1985 GOALS Management Plan despite Wachusett's extremely desirable location for such equipment. It is hoped that current technology will permit the consolidation of existing structures and equipment, thereby greatly reducing their aesthetic impact on the summit.

Chapter 205 of the Acts of 1996 provided 3.5 million dollars for state-wide telecommunications improvements. Between 2 and 2.5 million dollars of these funds are specifically designated for "the study, planning, design, and construction of a consolidated telecommunications facility at the summit of Wachusett Mountain". Plans call for the construction of a new fire observation post with public access, a single communications structure, and the removal of the existing fire tower and other communications towers.

The Ski Area

The 1985 GOALS plan was published shortly after the completion of the two phased expansion of the Ski area from 1981 to 1984. DEM recommended at that time, that no further expansion of the ski area should be considered for a five year period (September 1, 1984 - September 1, 1989) to allow sufficient time to assess the impacts, if any, of the expansion on the WMSR. In addition, DEM further recommended that WMA, DEM, the Advisory Council and the Towns of Princeton and Westminster work together to address concerns related to traffic control and off-season public events at the Ski Area.

Present Status Discussions between DEM, WMA and the communities of Princeton and Westminster with regard to vehicle traffic management have been on-going and constructive. During the mid to late 80's, a "Traffic Study Committee", comprised of representatives from WMA, DEM, Westminster, Princeton, MassHighway, the City of Fitchburg, and the Wachusett Mountain Advisory Council, conducted a comprehensive review of existing traffic flow problems. As a result of the committee's recommendations, significant improvements were undertaken by WMA to relieve traffic issues, including the construction of a new entrance road off of Bolton Road. Subsequent improvements instituted by WMA have included methods for local non-skier traffic to access Mile Hill Road without unnecessary delay, and the introduction of an FM radio frequency to inform the public of traffic conditions on Rte. 140 on an on-going basis.

Interpretive Services

Due to the significant natural, cultural, and historic resources of the WMSR, DEM considered the hiring of a long term seasonal interpreter and the development of public interpretive programs, brochures, and displays to be a high priority in 1985.

Present Status Beginning in 1994, DEM has hired an interpreter on a seasonal basis. In 1997 a qualified interpretive specialist was hired. Since that time, he has worked to implement the recommendations of the 1985 GOALS Plan, including development of public programming and interpretive signage and brochures.

Reservation staffing:

At the time that the GOALS Management Plan was published in 1985, the year-round staff at the Reservation consisted of a Senior Supervisor, an Assistant Supervisor and two Skilled Laborers. It was recommended in the Plan that four additional year-round laborer positions should be added to adequately address the maintenance, public recreation, and public safety responsibilities of Reservation Staff.

Present Status The current staffing at WMSR stands at five full time positions (an increase of one laborer position over the 1985 staffing level). The recent review of staffing needs at WMSR as part of the preparation of the RMPP resulted in updated DEM staffing recommendations which are presented in Section 6.4.

Forest Management

The 1985 GOALS Plan recommended that the commercial harvesting of forest products remain limited to the most productive sites within the areas of the Reservation identified as the Natural Resource Zone. It was estimated at that time that commercial timber and cordwood operations would be appropriate to less than 20% of the 2000 acres of WMSR. This recommendation was based upon DEM's recognition of the Reservation's primary values of watershed protection and public recreation, as well as the physical limitations on commercial forest products harvesting imposed by the Reservation's steep slopes and shallow soils.

Present Status Commercial harvesting of forest products from the Reservation has been limited to those areas designated as the Natural Resource Zone. Since 1985 a total of 12 forest product sales have been conducted, resulting in the harvest of 185,011 board feet of timber and 708 cords of fuelwood from this zone. All sales are planned and administered by the Department's Regional Management Forester. Commercial forest product harvests are designed to:

- Improve forest vigor by removing poor quality trees to promote the growth of the residual stand.

- Improve wildlife habitat by maintaining a diversity of forest types, tree species, age classes and wildlife food sources.

- Provide revenues to the Commonwealth.

and are conducted utilizing "Best Management Practices" in accordance with Department policy.

The zoning section in this RMPP addresses commercial forestry recommendations.

APPENDIX B

Cogbill Historical Ecology Report (Dr. Charles Cogbill)

AN ASSESSMENT OF THE HISTORICAL ECOLOGY OF THE FORESTS ON THE NORTHEAST SLOPE OF WACHUSETT MOUNTAIN, MASSACHUSETTS

A Report Prepared for Vanasse Hangen Brustlin, Inc.
by Charles V. Cogbill
7 March 1996

Scope of Work

There is current interest in both identification and protection of the few remaining old-growth forests in Massachusetts. Concomitantly, Phase II of the expansion of the Wachusett Mountain ski area proposes trails in an area containing trees identified as potential "old growth". In 1995, anecdotal observations by environmentalists drew attention to scattered large, albeit relatively short and gnarly, trees growing on the northeast slope of the mountain. Tree cores taken in August, 1995, indicate trees exceeding 200 years old in the area above the summit road.

Interest in "old growth" by environmentalists and managers has increased over the past 15 years. Ecological work with old growth, however, is still in its infancy. Old growth is unlike a wetland, for instance, that has reasonably distinct ecological characteristics. More importantly old growth does not have legislative definitions or regulatory procedures (old growth is not specifically protected in Massachusetts). Although ecologists agree on the general nature of older forests, there is so much variability among sites and forest types that no single characteristic of old growth is universally applicable. Despite the ambiguities, old growth is clearly a condition of forest communities, not individual trees, and involves some level of continuity through time. Old growth develops gradually when locations remain unaffected by major disturbance, but such forests are still dynamic.

Without either established ecological or statutory criteria, identification, assessing quality, or determining extent of eastern old growth is necessarily conditional. Regardless of the will-o'-the-wisp nature of old growth, objective criteria have been proposed by ecologist. Significantly the only ecologically-based survey done in Massachusetts (Dunwiddie 1993) - as well as most recent studies done in eastern old-growth - uses defiitions for old growth first proposed by the author for use in Maine in 1981. The current report assesses the possible presence of old growth based on these criteria (Anon. 1983). Necessary criteria include:

1. a minimum size homogenous area capable of continuously supporting a forest stand
2. minimum percentage of the maximum longevity reacheable by the dominant tree species
3. undetectable human influence
4. evidence indicating the presence of a subsequent tree generation.

The exact quantitative minima for stand size or canopy tree age are arbitrary. Obviously small or significantly (particularly human) disturbed sites are less likely to contain or maintain old growth characteristics. Operationally, a minimum size of 5 (Anon. 1983) to 12 acres (Dunwiddie 1993) has been used in previous studies. Similarly ages of 50% of the maximum longevity (equivalent to approximately 150 to 200 years old for northeastern forest species) are useful guidelines for old growth determinations. Regardless of exact quantitative characteristics, the critical determination is an assessement of specific stand historic integrity and continuity.

This report analyzes the extent and characteristics of the significant forests on the northeast slope of Wachusett Mountain. In order to assess the nature of the Wachusett Mountain forests, it first looks at the historical land use, then documents the vegetation in the region, and finally interprets the present vegetation resulting from this history. This research uses two independent lines of evidence to document the historical ecology: (1) cultural records of land use and forest conditions, and (2) evidence of vegetation composition and dynamics as revealed by field natural history. Both collation of regional trends in land use and collection of ecological data are used to objectively determine the specific conditions at a number of sites within the planned ski area expansion.

Setting

Wachusett Mountain is an isolated Monadnock and the highest point in eastern Massachusetts (2006 feet elevation). The "obtuse, conical figure" (Dwight 1821) is the result of a resistant sill of Wachusett's tonalite (a tightly folded series of intrusive rocks of the Fitchburg plutons) (Maczuga 1981). This has produced steep upper slopes with an gently east-dipping (inclined 15° higher in the west) with a distinct series of exposed ledges. Furthermore, the granodiorite bedrock has been prominently affected by post-glacial frost cracking producing associated "gneissic" boulder fields. These talus slopes are best developed at 1450 feet on the west slope above the Visitor's Center or at 1750 feet on the north side of the mountain above the "Oxbow" on the summit road. On the west side of the mountain the underlying Silurian age Paxton sulfidic schists form the bedrock surface supporting gentle slopes, less rockiness, and deeper, potentially richer, soils. Significantly the contact between these two rock types generally follows the toe of the steep rocky slope on the north side. The very summit of the mountain is a cap of overlying gray schist surrounded by a small piece of foliated granite distinct from the tonalite (Robinson and Tucker 1992).

The soils of the lower elevations are generally thin sandy loams derived from basal glacial till (thus reflecting local bedrock) and classified as Hollis series (Soil Conservation Service, Preliminary Worcester County Soil map). Surface deposits on the upper mountain area are veneers of organic matter over boulders or thin stony material with deeper pockets associated with Berkshire-Lyman soil types. Regardless of vegetation, the geology of the mountain provides a unique set of environments; including northern climates, talus slopes, thin acid soils, and long steep slopes, all not common east of the Berkshires or south of the mountains of New Hampshire.

Vegetation and land use on the northeast side of Wachusett Mountain

Original Wachusett Vegetation

The original regional vegetation in the Princeton-Westminster region is easily quantified by the presettlement surveys of the towns (Table 1). The witness trees documented in lotting surveys before 1755 indicate a mixture of over 25 species with general dominance by oaks and pines in Princeton and mesic mixed northern hardwood forest (beech-maple-hemlock) in Westminster, Historian Peter Whitney (1793) states that in Princeton the

> "growth of wood is oak of the various kinds, chestnut, white ash, beech, black birch, and maple; and near the Wachusett (sic) hills, some butternut is to be seen, as also some walnut, which will undoubtedly increase and spread. [In Westminster he found] "the high lands have all sorts of oaks, some chestnut, some walnut, which is increasing; they have had a great plenty of white pine, which is chiefly cut off, some yellow and pitch pine; the low lands are stores with ash, beech, birch, maple, and hemlock.

The surveys of routes of early roads (Table 1) in both towns confirm the contemporary qualitative descriptions, showing an abundance of chestnut and beech together with oaks. All these surveys characterize a varied early forest with a constellation of species of both southern (i.e., oaks, chestnut and pine on drier sandy uplands) and northern (e.g., beech, maple, hemlock or mesic lowlands) affinity.

Through the 1800s there was little change in the forest composition as Wachusett Mountain "on the sides, besides red oak, are rock maple, yellow birch, leverwood, beech, chestnut, shagbark, hemlock, striped maple, witch-hazel, etc., etc." (Thoreau 1854). Actual trees on the northeastern slope (Roper farm) noted in the 1800s (Table 1) show a dominance of oak, but a mixture of mesic hardwoods (i.e., chestnut, beech, ash). Significantly, despite the small sample size, this species composition is a good characterization both of other early records and, with the striking exception of missing chestnut trees, of the vegetation found today on the lower steep slope on the northeast side of the mountain.

The top of the mountain differed from the diverse lower slopes. Whitney (1798) observed "a flat rock, or ledge of rocks" on the top of which "where there is any earth, it is covered with blueberry bushes for acres around; as you descend the hill, there are very low and small trees, with flat tops, the further you descend, the taller are the trees, until they become of common size". Echoing this view in 1843, H.D. Thoreau observed, reversing the traverse,

> "denser forest, which gradually became dwarfed till there were no trees whatever upon the mountain crest, [Later on a second trip to the top of Wachusett Mountain Thoreau (1854) found] ...the prevailing tree on this mountain, top and all, is apparently red oak, which toward and on the top is very low and spreading.... Most of the deciduous woods *look as if* dead.

This is precisely the nature of the stunted oak forest presently found today on the gentle upper slopes of the mountain.

Unsettled Period 1734 - 1790

Although Wachusett Mountain was known to European settlers since at least 1632, land on its slopes was not granted for over one hundred years. The original Province grants clearly avoided the land on the mountain leaving it an isolated island, presumably less wanted for settlement (Blake 1911, 1915). The earliest written account of the vegetation of "the Great Wachusetts Hill" came just after settlement when Peter Whitney (1793) observed that "one hundred acres of it be worth little or nothing, yet most of the remaining three hundred acres will make considerable pasture land, and some parts very good...[but] upon the east north and northwest it is very broken and ledgy; many acres utterly unimprovable any way at present." Princeton became a patchwork of rants to groups of proprietors as well as smaller parcels to individuals. Starting in 1736 Massachusetts sold its remaining "Province Lands" on Great Wachusett Hill to Princeton's minister, Rev. Timothy Allen, and wealthy landholder, Benjamin Houghton (Blake 1915). Some better lands were quickly cleared such as on the Potash farm (eastern corner of Princeton) where in 1762 "the most valuable part of the timber of said farm is cut...apparently within the last two years." (Province records cited in Blake 1915.) The land near the mountain, however, remained unsettled until after 1790 when individual parcels were sold on the lower slopes surrounding the mountain. These included 156 acres on northeast side of Wachusett bought by John Roper in 1790. The roughly 550 acre core around the summit remained undivided, passing as a single "Mountain Lot" among local prominent landholders (see Table 2).

Pasture Period 1790 - 1873

Typical of hill towns in central Massachusetts, Princeton in the mid-1800s had many summer boarding houses, farms raising cattle for the Boston beef market, local small industries especially chairmakers, and gentleman farms of larger landholders (Blake 1893, Whitney 1994). The summit area itself was a destination for visitors as seen in Thoreau's visits in 1843 and 1854, but not "improved" until after 1866 (Blake 1915). The north slope of Wachusett was apparently marginal farm land, supporting the Roper family farm for over 100 years, in addition to pastures for cattle, and woodland admired by tourists. By 1830 only 4021 acres of woodland remained in Princeton; the vast majority was a circle covering Wachusett Mountain, with small caps on Pine Hill and Little Wachusett, and a strip northeast of the mountain along the town line (Massachusetts 1830). The largest block of forest in Westminster in 1830 was contiguous with this strip, covering several hundred acres between Wachusett Lake and the north slopes of the mountain. Interestingly, there was a small "bite" in this strip north of the dead-end in the road, indicating active clearing for a small nearby pasture on the Roper farm. Significantly by 1830 the forest had been cleared up to about 1500 feet around the whole mountain, except near the Roper's.

John Roper was born in Sterling and began a homestead farm on the north slope of Wachusett in about 1791 (Blake 1915). Before his death in 1833, he passed the property to his two sons who alternately shared the "Roper farm" until 1896. The eldest son, John Jr., occupied the 118 acre farm until moving to Westminster in about 1869. John Roper Jr.'s younger brother Wilkes was a farmer who became a part-time hotel keeper when he started a boarding house at the Prospect House (Princeton Inn) in 1860. In 1870 Wilkes took over the family farm from his brother, but also ran another boarding house (Fernside) in summer (Blake 1911, 1915). Farming activity for these brothers (Table 3) indicates that the Roper farm was a typical small (sometimes part-time) farm with 4 to 10 milk cows primarily producing 175 to 700 pounds of butter each year. This farm was made famous by the poem "Monadnock from Wachusett" by J.G. Whittier based on a visit in the 1860s. The pastoral scene and activities are conveyed in Whittier's poem citing the daily cow movements as "pasture-bars that clattered as they fell", extensive pastures as "the shorn greenness of the clearing" and the forest beyond the pasture as "the great woods climbed the mountain at our back". Whittier also used a bit of literary license as he alludes to "haring the bleat of sheep along the hill" [interestingly farmers near the mountain kept few flocks of sheep, and the Ropers had none], and seeing "the sunset over the lake" [the lake is actually east of the farm]. The Ropers had a few beef cattle, and the adjacent land was used by several local farmers to pasture herds of 10 to 40 cattle raised to sell for meat (Table 3).

In 1873 Wilkes Roper sold the "pasture and woodland" on the southeast of his farm, abutting the mountain, but he reserved for 4 years the right to "cut down and carry away all wood and timber remaining" on the northeast corner of the Roper pasture (WCS 984-535). Apparently the pastures were virtually cleared by this time with the only remaining timber worth cutting located on in a 'back woodlot' along the town line. Considering that there were only 25 ac of woodland (15% of his ownership) on the Roper farm in 1870 and 11 ac remained after the pastures were sold, it seems likely that a small part of the "dovetail" between the Cozzens' and Parker's pastures (Fig. 1) supported part of this 10 acres of woodland. This back woodlot was presumably used for partial cutting, supplying the roughly 8 cords of wood for domestic heating need by the farm.

In 1880, 162.5 acres of the Cozzens, Roper and Parker pastures north of the new mountain road were sold to Mary Baker. There was a right-of-way to drive cattle, and the user was required to "keep fence except where the embankment mass forms a sufficient fence" (WCD 1098-283). Apparently the land was still used as cow pasture through 1900, as seen in contemporary pictures (Kingsley and Knab 1895, Princeton 1900). Incidentally the upper limit to the Cozzens pasture is marked today by old barbed wire fence. but steeper slopes to the east have no indication of the old property line. (Fig. 1).

The extent of the cleared land on Wachusett Mountain is easily delimited by either property boundaries of the pastures (Fig. 1), stone walls (easily found today--see Chase Map) marking the shapes of most lots, or nineteenth century pictures (see postcards at Visitors' Center; Kingsley and Knab 1895, Princeton, 1900.). All evidence shows an abrupt edge to the farm pastures that extend up to the toe of the steep boulder slopes around the "waist" of the mountain. This clear "treeline" exactly followed the route of the road to the "Oxbow" hairpin and then after a jag angled up to the northwest shoulder of Wachusett (Kingsley and Knab 1895). Obviously the area northeast of the mountain was one of the last, if at all, to be cut in the two towns. Specifically the Roper farm was partially forested (between an estimated 50% woodland on the 1830 map and 25% in the 1850 census). After 1850 the Ropers expanded the farm and, despite increasing the total acreage, the amount of woodland continued to decrease from 30 acres in 1850 to 25 acres in 1870.

Much of the timber cleared from the farms in the nineteenth century went to local mills. In 1845 the Ropers were apparently still clearing their farm and were selling "wood and timber" (WCD 406-114) to local loggers (e.g., one Smith who produced 500 cords in 1850) or neighbors. In 1860 there were six sawmills in Princeton which cut a total of 1350 thousand board feet of lumber (U.S. Manufacturers Census, 1860). From 1850 through 1860 Roper's next-farm neighbor, Ephraim Osgood, operated a sawmill which cut 100 thousand board feet of timber a year producing "oak, pine, and chestnut boards". Considering the close match to original forest species and the close proximity, much of this cut must have come off the slopes of the mountain including some from the Roper farm. The region had many local timber-based industries using hardwood trees and was famous for chair manufactures (e.g., J. Foskett living on the adjacent farm, who had a chair factory) (Heywood 1893). Also in 1850 S. Everett operated a tannery just east of the Roper farm, using 45 cords of hemlock bark. Logically some of this bark came from the pockets of hemlock on the steep slopes of the mountain.

Tourism Period 1873-1962

A stone house was built on the summit in 1870 and the mountain became a tourist destination for summer boarders. With the purchase of the core of the upper mountain by the Wachusett Mountain Company in 1873 there were ambitious plans for a cog railway (W. Sinclair, pers. comm.). The Company consolidated ownership of the surrounding land on the north side of the mountain and built a road to the summit hairpinning up the least steep part of the northeast slope. The road crossed through the upper part of former Cozzens', Roper's, and Parker's property (see Fig. 1). In 1877 the Wachusett Mountain Company went bankrupt and the ownership was taken over by Charles Brigham. The sections of pasture north of the road were then resold following the old property lines and apparently continued as grazing land. The uppermost slopes of these pastures probably had traditionally been used as a combination of thin woodlots, woods pasture, or unmaintained pasture edge. In 1880 they were cut off by the road, abandoned, and allowed to regrow as part of the slightly modified "mountain lot". Continued development at the base of the mountain included building of a road which went across the saddle west of Pine Hill, bisecting Parker's pasture and past Roper's house, to Wachusett Pond (Blake 1911). In 1882 P.A. Beaman bought the mountain and soon developed the summit, adding buildings, including a three-story hotel (Blake 1915).

With the creation of the Wachusett Mountain State Reservation in 1899 most of the land on the mountain was quickly bought or taken by condemnation by the Commonwealth of

Massachusetts. The land was managed by the Worcester County Commissioners primarily as a park. Generally the forests suffered from benign neglect, but received some forestry management. For example, in the 1930s there was "pruning, thinning and harvesting of mature trees in selected areas" (Hitchcock 1971). The main efforts in this century were to improve the roads and other facilities. For example, the original summit road was upgraded by prisoners about 1912 and in 1926 completely rebuilt, including blasting through the steep rock slopes.

Although there were no documented agricultural activity (such as fences, fields, or cows) associated with the summit house, the surrounding forests were probably utilized by their owners (Hitchcock 1971). Certainly some trees beyond the naturally barren area on the top of the mountain were cleared to maintain the 360 degree view. In 1875 owners reserved the "right to cut all the wood and timber within 1 year" (WCD 954-502), likely for clearings for heating wood, or for accessible valuable species. In 1895 the mountain lot was still forested. Cheney (1895) wrote prophetically that

> "practically the entire surface of the [550] acres...is covered with a dense and impenetrable forest growth of trees and shrubs, and these include almost every species and variety in the sylvan of Worcester county. This great forest expanse is of special interest and value because it is an original or primeval growth, and as such is the only one of any considerable extent in the county. Here one can see trees in every stage of existence, from the tiny seedling to the aged oak and hemlock, that completed their growth above a century ago.

In direct contradiction, Heywood (1893) states at the same time that "original growth of wood and timber was years ago cut off" the slope of Wachusetts. In fact, Fisher (1906) described the results of cutting with

> "the forest in the reservation...mainly in poor condition. The great bulk of it consists of sprout hard woods, chiefly red, black, and white oak, hickory, beech, chestnut, white ash, sugar and red maple. Most of it has been cut clear several times already, and the present stand, in blocks of various ages from ten to fifty years. In addition to the main [second-growth] hard wood, there (were) scattered bodies of hemlock, occurring on the steep ledges south and west of the mountain and in the ravine above the deer park. The trees are old and of slow growth."

This paradox continued through the present with divergent views of the history of the forests on the mountain.

The apparent resolution of the contradiction is the spatial frame of reference and the perspective of the observers. Certainly the accessible and merchantable timber on the lower slopes (former pastures) of the mountain was cut; and from an agricultural or forestry perspective the potential farm or woodland had been cut. At the same time the inaccessible and unusable trees on the upper mountain had been left; and from an aesthetic or tourist perspective, the wild and scenic landscape had not been cut. In the semantics and philosophy of the time; the pastoral landscape was completely improved and the remaining sublime landscape was all wild.

There were small oddities, however, which were exceptions to both these landscape generalities. Valuable species such as spruce or white pine were selectively cut wherever they occurred, which must have included the rocky slopes of Wachusett. At the same time, as Fisher (1906) observed, there were pockets of forests even within the pasture areas which were not cut, either because they were unreachable (e.g., hemlock on ravine slopes, yellow birch on boulder fields), damaged and stunted (e.g. gnarled oaks), or supported species less commercially valuable at the time (e.g. beech in back woodlots, striped maple in impenetrable thickets). Finally much of the distinction between the two absolute histories is obscured with time as natural disturbances such as hurricanes, land slips, or chronic ice damage drastically reduced the potential age and forest structure in uncut areas; and rapid regrowth perhaps mixed with older holdovers from fencerows or cull trees in woodlots quickly increases the age and forest structure in cut areas.

Recreation Period 1962 -

Although the first ski trails on Wachusett Mountain (near Balance Rock and a "fast [Pine Hill] trail on the east slope") were cleared in the 1930 (Hitchcock 1971), there were neither lifts nor open slopes on the north side of the mountain. Recreational activity was limited to use of the summit road for access or views or the "Indian trail" for hiking. After initial approval in 1958 the state constructed a ski area on the slopes of Wachusett Mountain in 1962. Curiously, the ski area covered virtually the same terrain as the original Roper Farm. The "Oxbow" lift extended to just above the summit road near the old tree line in the upper extent of Roper's former pasture. A trail was also apparently cleared from the summit following the exact path of present "Balance Rock Trail" (upper 8a). After being operated by the state for five years, a 450-acre tract extending to the summit was leased to Wachusett Mountain Associates in order to operate the ski area. In 1982 the ski area expanded with a lift to the summit and three new trails cut through the slope above the summit road. One ski trail (#8) was purposely routed around the slope to preserve a small patch of large hemlocks on the steep, rocky slope to the east of the lift line (T. Lynch, pers. comm.). Apparently this is the same forest recognized as an "excellent hemlock stand on the north slope at 1550 feet" in a 1972 planning report (Sno-Engineering 1972). During the cutting of the trails in 1982 many large trees were removed with difficulty. Although nobody studied the natural history of the area of recognized it as significant at the time, anecdotal stories indicate that the loggers were impressed with both growing conditions and the unusual trees removed (J. Crowley and T. Lynch pers. comms.).

Forest Dynamics and Current Vegetation on Wachusett Mountain

Natural Disturbance

Even when unaffected by human activity the vegetation on the mountain was affected by natural disturbances. In fact, the exposed high elevation vegetation was shaped by constant wind, snow, rime, and ice-caused stem or branch breakage. For example, there was severe damage from an ice storm in November 1900, when "whole trees and shrubbery suffered" at higher elevations (Ann. Rept. WMSRC 1901). The prevalence of shrubby striped and mountain maples is the typical response to this canopy damage. The stunted, pruned, gnarled trees on the summit or exposed ledges are characteristic of chronic disturbance. Southern New England is also affected by occasional hurricanes (Foster 1992). The 1938 hurricane "destroyed thousands of the largest trees on the south and west side of the mountain... [and] large hemlocks and pines were completely leveled" (Hitchcock 1971). There was also reported damage on the mountain from Hurricane Carol in August 1954. Thus, much of the forest which had survived cuts in the earlier century was now younger. Only trees with short, stocky stems (stunted summit oaks), on the lee side of the mountain (such as the northeast slope in 1938), or in sheltered locations (e.g., toe of steep slopes) remained intact. Apparently a major disturbance (fire, wind, or human?) affected the area on the east slope, that shows as an open scar in the forest above the road in an old photograph (Kingsley and Knab, 1895), where there are many white birch growing today. In addition to wind disturbance and prominent ice deposition on the exposed elevation, the steep talus slopes are moderately unstable and slips and surface erosion are common and characteristic of this mountain.

The forest of the region, especially oak and pine dominated areas, was originally affected by recurrent fire. Surprisingly, despite the oak dominated forest and its elevated "lightning rod" position, there has been no major fire documented (either written or ecological evidence) on the mountain. Logically, this would indicate more than 350 years without fire if the lack in the historic record is accurate. There is scattered charcoal in the soil on the upper slopes, but it is limited, and no fire scars were found on trees. Apparently fires from clearing of farms or pine plains did not spread up the steep mesic slopes.

North Slope Vegetation

A perusal of aerial photographs and quick reconnaissance of the area around the (existent and proposed) ski trails above the summit road revealed an elevational series of forest communities. Forests vary from mixed hardwood forests on the lower slopes up through sparse shrub-prominent forest on steep talus boulders to a brow of drier, stunted oak on the flatter summit crown. The vegetation zones are directly related to topography with the granodiorite sill forming the steep slopes and ledges at the middle of the gradient. The outcrops form a gently dipping belt around the upper mountain. Somewhat deeper, but still rocky, soils in concave ground between or below the ledges are more sheltered and moist (mesic), while the concave or exposed upper slopes have thinner, drier soils and area is more stressed. The vegetation on the shallow, rocky soils is a mixture of species, but varies from oak-beech-birch on breaks between ledge; to birch/shrub on boulder talus; to hemlock on rocky (and seepy?) slopes; to spruce on bony ledge (i.e., at least west of the Old Indian Trail). Below the old property boundary, just above the Oxbow, there is a change, with second-growth species such as white pine, white ash, red maple, mixed with the ubiquitous mesic hardwoods. Logically, pasture land or woodlot is more productive than the thin, soiled, ledgy upper slopes. Despite similar appearance, the lower slope individual fence row (trees (e.g., shagbark hickory found west of 5A or fast growing ash and oak woodlot trees (e.g., within the bow of the Oxbow) are taller and better formed than the upper slope slow-growing oaks and birch. The difference in forest composition between the suite of communities on the upper mountain is related to underlying substrate, while that of the lower mountain is due to different land use history.

As part of this study I also sampled the vegetation on the north slope of Wachusett Mountain. The work was done on four days in October, November and December 1995; thus, little of the herbaceous vegetation was seen (except for the prevalence of evergreen wood fern on soils and rock polypody on the talus) and neither understory nor total flora (including cryptogams) are considered here. The characteristics of five different communities identified in the reconnaissance were quantitatively determined. Tree composition (% basal area > 5 cm dbh), stand structure (canopy height, maximum tree size, total basal area, dead wood basal area), tree ages (stand average) and forest soil development (horizon thickness, charcoal presence) were used as indicators of stand development and history of the sites. Thirteen tree cores were taken, transported to the lab, prepared and the ring count read under a dissecting microscope. These counts were combined with eight trees cored by Peter Dunwiddie and two trees sampled by Chuck Pernaa to get an objective, although minimal, estimate of tree age (Table 4). Median age of uncorrected ring counts at breast height of canopy trees is used as the estimate of stand age. This average parameter, easily determined from a small sample, is generally considered to be a robust estimate of the minimum age of a "typical," but real tree in the forest. Median age is relatively unaffected by tree choice, individual outlier ages, incomplete cores, missed centers, correction for height of coring, sampling errors such as miscounted years, or assumptions of age structure.

Four of the site samples were preliminary evaluations using a cursing prism, while one intensive sample was made in a central area. The latter relocatable sample quadrant was established at 1670 feet elevation at the toe of the boulder slope. This plat, incorporating the first three trees cored by Dunwiddie, exactly spans the proposed 5A trail. It is also within the mountain lot, but just beyond the traditional properly line of the "Cozzens' pasture." The sample is considered a valuable reference as it was typical of reference to current condition and possible control for alteration by future trail development.

The stand data (Table 5) show variable composition, with an ubiquitous presence of yellow birch and a basic composition of mesic hardwoods. Beech is well represented across all conditions, with more sugar maple on the better (mesic) end and red oak at the drier (xeric) end of the gradient. The forests have only moderate mass with 31 to 36 m^2/ha on lower slopes, the expected maximum (46 m^2/ha) in conifer dominated areas, and a fairly low 20 to 24 m^2/ha on upper slopes. Canopy height and tree diameters are also within the range found in the regional woods, with the subtle (indistinguishable in stand averages) exception of the scattered trees reaching 70 to 85 cm dbh on the upper slopes. Interestingly, dead wood is relatively sparse (21% dead:live in the intensive plot) but in accord with the rapid decay of hardwood in moist climates. The one dramatic measure of these stands are the ages (Table 4). Except for the area within the Oxbow, many sites have trees exceeding 200 years and the average age of sampled trees is generally over 150 years.

Site Histories

Vegetation on the north slope is composed of four community types. The "Toe" community is dominated by northern hardwoods occurring on the lower portions of the steep slopes. The "Ledge" community on the steeper outcrops/talus on the slope just above the Toe is dominated large yellow birch and an understory of mountain maple. The "Hemlock" community is dominated by hemlock, with a mixture of ther hardwoods in moist and rocky areas on the steep slope. The "Brow" community occurs on flatter slopes above the steep ledge outcrop. Specific sites within each of these communities were studied to elucidate the general condition of that community on the mountain.

Detailed age data are only available from the 10 cores within the vicinity of the Toe (#1) site. Here the median age of the sampled trees is over 172 years and the oldest tree is in excess of 295 years. The age structure indicates that the red oak and yellow birch are approaching their maximum age. The beech and sugar maple are faster growing and slightly younger, tending to be around either 130 years or 200 years old. Interestingly, six of the ten trees cored either began growth or were released (spurted in growth) 140 to 160 years ago (=1830-50) and four were released around 80 years ago (=1910). Evidently there have been several partial disturbances in this stand over at least 300 years, but no large (0.1 ha) catastrophic disturbance. The existent trees are in several different "cohorts," but significantly missing are small (or young) oak trees; no cored canopy trees were less than 100 years old. this stand is on a well developed, but shallow, spodosol soil with a pH of 4.04 (also the surface mineral soil as 12.6% organic matter and 135 mg/Kg available CA^{++}). There is a trace of old charcoal in the soil, perhaps explaining the establishment of the old oaks over 300 years ago. The moderate, but still acid, growing conditions together with the sheltering slopes to the south and west preventing weather damage, yields an increasing representation of maple and beech over the last 200 years.

The other sites have limited tree core data, but we can speculate on their history (Table 5). The Talus (#3) site age (>>133 years median age) is based on three scattered yellow birch and reflects the slow growth and gnarled, but stocky, trees growing directly on rocks. There is no indication of major disturbances (rock falls, windthrows, or fires), but there is constant canopy damage resulting in branch loss, "staghorn" canopy and trees mortality (10% dead:live BA).

The Brow (#4) site has the mesic beech and birch mixed with xeric indicators such as nearby black or white oaks from the summit. Curiously the oaks (one cored over 206 years old) on the crest of the mountain have either huge ground level stools or double stems, indicating an old major disturbance. The site has deep organic/rocky soils, with no discernible charcoal. the over 123-year-old beech indicates continuous forest (beech establishes slowly in fields or pastures) and at least this long since stand disturbance. Since oaks reproduce well after either fire or cutting and oak ages exceed 200 years in several locations, it is probable that the last fire (and oak tree initiation event) on the brow was centuries ago. Significantly there is at least one oak stump at 1810 feet which had a flat top cut, indicating at least some selective 20th century cutting in the vicinity.

The hemlock (#5) site is a patch between ski trails 7 and 8 and has many large and hollow trees, one of three cored (median age of >>146 years) is over 240 years old. The large trees are prone to blowdown as suffered by the tree which recently provided the old age determination. This stand can be seen in the 1895 photograph having much the same extent and condition. It is probably one of the areas referred to in early reports of uncut hemlock patches on the mountain. However, much of this forest type could have been used historically for tan bark at the approximate time (≈ 1860) of establishment of the youngest cored tree. The stand has an abrupt western (along a small stream channel) boundary, but blends into mixed woods on the ledges to the east and north (beyond the down road). The boundaries might be due to increasing slabby substrate in the hemlock stand, or the edges of old large gaps (blowdowns) disturbances. This stand is dissected by the summit road and two ski trails.

The 8A sample (#6) at 1500 feet is east of the bow of the "Oxbow" and in the middle of the proposed new (lower) section of the trail (Figure 1). Both trees cored are about 130 years old and the abundant ash and multiple stemmed oak indicated widespread disturbance just previous to 1864. The area is in the far corner of the "dovetail" of Roper's pasture (Figure 1), but the old pasture stone walls did not extend past the present lower road. There is no plow layer in the shallow rocky soil and a 1895 picture showed forest covering the area. Obviously it was beyond the stone walls and not quality pasture as were the adjacent (Cozzens or Parker) grazing fields held as separate parcels. There is a gradual boundary (with more hemlock) to the south (upslope) as it gets slightly rocker and crosses the unmarked (but not forgotten) property line of the former mountain lot.

It is unclear how much of Roper's "dovetail" woodlot (W) area was cleared, or if the site was just used for woodlot or woods pasture. Although chestnut was formerly prominent on the gentler slopes, there are no chestnut stumps, downed stems (the wood remains for nearly a century), or sprouts on this site. This implies that either the chestnut's former range stopped just short, or it was removed by logging. The latter is likely since at settlement there were both a chestnut and a hickory (erstwhile "walnut," no longer present), witness tree on the old lower boundary (along the road) of the site. It appears that the chestnut was removed long ago (before the blight) and the original cutting was either severe or followed by pasturing (sprouts are persistent in woodlots, but not pastures). The forest today is well stocked, valuable, and operable for forest harvest, which has been recently proposed (DEM 1979), a little over 100 years after the last harvest.

Field reconnaissance and air photographs document a small segment of the hemlock type below the down road at the junction along trail 8 at the proposed extension of the 8A. There are very large oaks (to 90 cm) near the talus to the northeast, which together with the hemlocks apparently delimit the former "dovetail." Apparently the scattered 50 cm oaks over most of proposed 8A the site date from its use as a woodlot. There is a gradual change leading up to the hemlocks. A strip below the summit road was historically cleared as a vista and presently contains a younger forest, including white birch and white ash, surrounding the relatively larger hemlock timber to the southwest.

Although the upper mountain is currently bisected by four ski trails and a lift line, the adjacent forests appear relatively unaffected (little edge windthrow, hydrologic changes, or off trail trampling). The trails are typically lined by brow forest containing scattered large and "weathered" trees (red oak, yellow birch and beech). Each of the four extant trails has snowmaking pipelines generally running through the woods beyond the edge of the trail. In addition to the initial small size of the forest patches between extant trails, environmental edge effects (roughly one tree height or approximately 50 feet) the trail disturbances extend as a border effectively reducing the present extent of undisturbed forest in the isolated islands to a tiny area.

Evaluation of old growth status

The forest just beyond the upper pastures on the northeast slope of Wachusetts Mountain has always been isolated by topographic (steep, rocky), ecologic (low productivity, forest history), and cultural (ownership, economic, aesthetic) boundaries. It was inaccessible except across the surrounding pastures of different ownership. Although potentially used by local farmers and managers for various purposes through 200 years, land beyond the formerly abrupt pasture/"treeline," has been continuously forested. Virtually all the upper 550 acres on the mountain were classified as woodland in the mid-1800s (U.S. Agricultural Census 1850 and 1860) and has obviously been little "used" since. Owners intermittently used small areas--where the boundaries were indistinct, less steep, or around the perimeter of open land--for woodlot and woods pasture. On tonalite bedrock which is a belt that wraps completely around the mountain, the geomorphology has always severely limited both the vegetation and its use. Thus, beyond the obvious road and ski trail construction, the belt of forests above the toe of the slope, except at its lowest fringes, is generally undisturbed by human activity. The historic property boundary between the mountain lot and farmers' pasture land (Figure 1) is a convenient and reasonably accurate boundary for this forest history.

As documented above, the trees cored on the "mountain lot" on the north side of Wachusett Mountain average over 150 years old at several locations, with a grand median of more than 177 years for 19 trees. In addition, some of the oldest red oaks and yellow birch yet documented in New England are found here. Since hardwood trees seldom survive for 350 years, this cluster of old trees meets the age (2nd) criterion for old growth.

Not only are there old trees on this slope, but in most areas there is a mixture of younger trees, indicating gradual replacement in these stands. Note that the median age exceeds 50% of the maximum longevity of mesic hardwood species and is consistent with the mathematical expectation for dynamics in continuously maintained forests. This indicates active replacement and easily fulfills the continuity (4th) criterion from old growth. Both cultural history and stand reconstructions indicate lack of human influence or catastrophic disturbance, thus qualifying it as old growth under the disturbance (3rd) criterion.

Most of the 22 classification units on the upper mountain are part of formerly extensive belts which have been bisected by the summit "down" road or ski trails (Figure 2). These units are contained within 11 contiguous areas, mostly small stands in narrow strips or pockets due to extensive past fragmentation. In most cases, especially the ledge and hemlock types, small isolated pockets are naturally restricted by the substrate. At least two larger composite areas partly within the leasted area exceed the largest arbitrary minimum criteria of 12 acres. One undivided area (T1, L1, B1) with an elevation sequence of four types (including toe, ledge and brow) over an estimated 38 acres, is found across the ledges on the west of Trail 5 above the old propoerty line at the toe of the slope. Another contiguous area (including L3 and T4) of at least 9 acres from within the lease area and at least 35 acres outside of it is found to the east of Trail 8 and above the old property line between the summit road and the Park Headquarters.

The area evaluated for significant forest conditions is surrounded by the summit road, old property boundaries, and the summit proper. It is roughly above 1500 feet elevation within the (vaguely defined) lease boundaries and mostly part of the original 500 acre "mountain lot (see Table 4 and Figures 1 and 2). Despite relatively homogenous conditions, the upper mountain supports several different forest types. This area has been subjectively divided into six vegetation types (same as the five sample units plus "used" areas such as roads or young growth in old clearings). Collectively each of these types covers from 15 to 40 acres with an estimated 22 acres of Toe, 18 acres of Ledge, 10 acres of Hemlock, and 36 acres of Brow. The undisturbed forest generally extends across the entire slope but is severely fragmented by the bisecting ski trails, albeit mostly on less ledgy areas. Specifically not identified as old growth is the forest in the "dovetail" on the lower half of trail 8A. This areas is exactly on the seam between early farming pastures and unused woodland as woodlot disturbance blends into the hemlock stand above it.

The significance of the Wachusett Mountain northeast slope is heightened by the diversity of the distinctive vegetation types supported in this small area. In addition to the long recognized significant hemlock stands, there are five other significant distinct forest types (mesic deciduous toe, birch tal[illegible]drier beech-birch-oak brow, unsampled mixed-oak summit, and unsampled red spruce ledge[illegible] the north slopes of the mountain. The types have yellow birch in common, and are regularly mixed with mesic hardwood species. All of the vegetation, except the oak communities, display a distinct northern affinity. The most unusual type of the mountain is the yellow birch talus community. The nearest similar communities in Massachusetts are designated natural areas and old growth sites in the Berkshires (e.g., Ice Glen, Stockbridge; South Mountain, Pittsfield; or gorges in the Deerfield River Valley). The suite of sites is like the gradient of conditions found at Money Brook in the Hopper on Mt. Greylock or Five Brook in Monroe (Dunwiddie 1993). A comparison of old growth sites in Massachusetts places the intensively sampled toe stand vegetationally somewhere between the forest communities found at Cold Brook in Savoy, Fife Brook in Monroe, and the Beinecke stand in Williamstown.

Although there has been little ecological documentation of old stands elsewhere in Massachusetts, some 350 acres are currently recognized as old growth (virtual all from Dunwiddie 1993) by the Massachusetts Natural Heritage Program. Several of the Wachusett sites have documented characteristics of similar quality to the old growth sites currently recorded. The series of stands on the north slope of the Wachusett is clearly more significant than the Heritage-registered "significant old growth" red oak near Bolton Pond in the northern part of the Reservation. The total area identified on Wachusett Mountain is roughly one-quarter of this state total and apparently the second largest (after Cold River) area currently documented in the state (Dunwiddie 1993). Based on heightened public interest and recent anecdotal searches, it is very likely that intensive reconnaissance will locate additional or expand currently known old growth sites in the state. While some of these sites may be similar, even adjacent, to the few well known sites, some new sites would certainly have a dissimilar composition, appearance, or environmental setting. Although the percentage of the state total on Wachusett Mountain will decrease with further discoveries, both the unusual forest types and undisturbed nature of the Wachusett vegetation make it regionally significant.

The variety, extent and condition of the potential old growth on Wachusett is surprising considering it is one of the first sites recognized in eastern Massachusetts. Due to different criteria, vague use history, prominent natural disturbances and current fragmentation, any estimate of the extent and total amount of old growth on Wachusett is conditional on quantitative (and currently lacking) criteria, and is ultimately inaccurage. Despite the necessary imprecision, the area extends well beyond the 7 acre stand initially identifed west of Trail 5.

Conclusions

- This research uses independent lines of evidence from cultural records and forest stand dynamics to document the historical ecology of the northeast slope of Wachusett Mountain.

- Regardless of vegetation, the geology of the mountain provides a unique set of environments: including northern climates, talus slopes, thin acid soils, and long steep slopes, all not common in eastern Massachusetts.

- The difference in forest composition between the suite of communities on the upper mountain is related to underlying substrate, while that of the lower mountain is due to different land use history.

- The forest communities at several locations on the north side of Wachusett Mountain average over 150 years old. Residual fragments are generally undisturbed by human activity.

- The forest within a belt across the north slope is severely fragmented by the bisecting summit road and ski trails.

- Both the unusual forest types and the undisturbed nature of the vegetation make it regionally significant. The significance of the northeast slope is heightened by the diversity of the distinctive vegetation types supported by this small area. Both the unusual forest types and undisturbed nature of the vegetation make it regionally significant.

- Further work with tree cores and stand history should be done to confirm the general observations at specific sites (especially the oak summit and brow, the yellow birch ledges, and the red spruce stand on the western eyebrow).

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Interviews

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Nancy Flanders, Princeton, MA. granddaughter of P.A. Beaman, proprietor of the Summit House.

David Foster, Petersham, MA. director of Harvard Forest and forest ecologist

Bob Leverett, Holyoke. MA Old growth sleuth and environmental organizer

Tom Lynch, former district forester and member of Princeton Conservation Commission

Chuck Pernaa, Clinton, MA, regional forester DEM

Warren Sinclair, So. Gardner, MA, local historian

Pat Swain, Massachusetts Natural Heritage Program Westborough, MA

Rich Valcourt, DEM forester, Clinton, MA

Ronnie Waters, Princeton, MA President of the Princeton Historical Society.

Anita Woodward, Princeton, MA. local historian

Table 1. Natural tree composition of Wachusett Mountain region (based on presettlement witness tree composition--data from Proprietors' Books in Princeton and Westminster and Town Records of Road Returns in the same towns) .

	Lotting surveys		meadow lots	Road returns		Roper Farm
	Princeton	Westminster	Westminster	Princeton	Westminster	Princeton
	1734-1738	1736-1755	1740	1763-1793	1751-1805	1790- 1869
	------% witness trees %------					
# trees	127	245	112	158	52	17
red oak	2.4	6.1	0.9	3.8	13.5	35.3
white oak	10.2			8.2		
black oak	6.3			8.9	11.5	
oak	2.4	1.6		6.3		
rock oak	0.8					
grey oak				4.4		
pine	7.9	2.0	27.7	0.6		
white pine	14.2	3.7	11.6	7.0	5.8	
pitch pine	7.9	1.6	1.8	3.2	3.8	
horn pine				0.6		
chestnut	3.1	9.0	1.8	28.5	25.0	17.6
butternut				1.9		
walnut	0.8			1.3		5.9
rock maple				1.3		
maple	9.4	11.0	27.7	3.2	9.6	5.9
white maple					1.9	
beech	7.1	19.2	1.8	4.4	11.5	17.6
black birch	2.4	2.9		3.2	1.9	
white birch	0.8					
birch	0.8	3.3	2.7	0.6	3.8	
hemlock	7.1	19.6	12.5	4.4	7.7	
ash	5.5	5.3		0.6		
white ash	2.4	0.8		1.3		17.6
black ash				0.6		
popple	4.7	2.4	0.9	3.8		
leverwood		0.4		0.6	1.9	
basswood			0.9	0.6		
boxwood		1.6				
elm	0.8	0.4			1.9	
cherry	2.4		2.7	0.6		
spruce	0.8	4.5	6.3			
juniper		0.4				

Table 2. Chronology and ownership (transfer arrows from grantor to grantee indicate documentation from Worcester County Deed Registry) of four parcels on the Northeast slope of Wachusett Mountain, Massachusetts. All in Province Land not granted to Watertown (1637); to Rutland Proprietors (1686); as Naragansett #2 (1728); or Kneeland (1735)

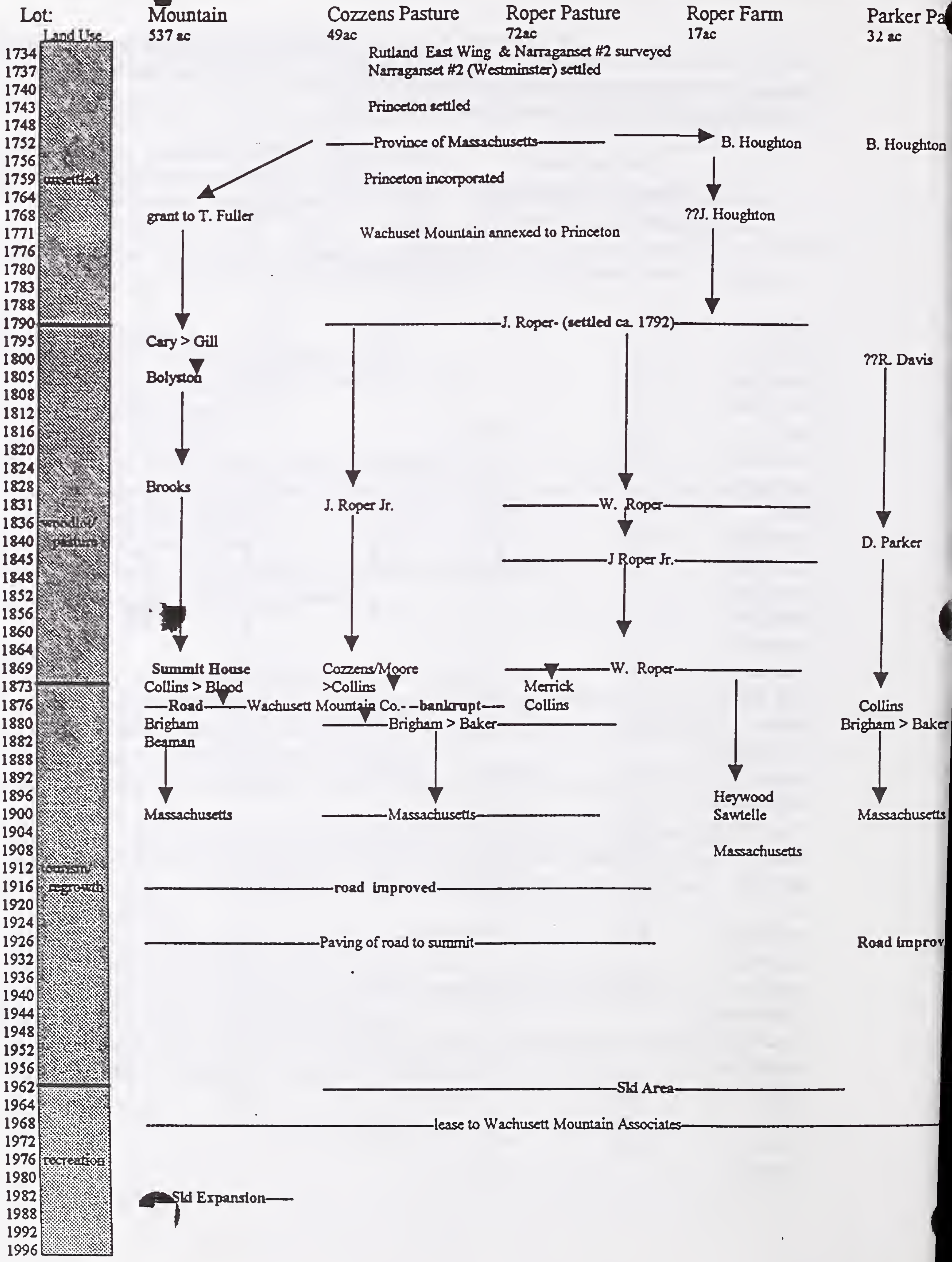


Table 3. Use and Production of selected farms on the slopes of Wachusett Mountain in Princeton (data from U.S. Agriculture Census schedules).

	imprv'd ac	woodland ac	cows #	butter lbs.	cattle #	potatoes bu	hay tons
Roper farm (118 ac in 1845 and 95ac in 1880) --including 49ac Cozzens pasture to 1869 & 72ac Roper pasture to 1873)							
1880 Wilkes Roper	84	11	10	700	9	100	
in 1880 addition:20 ac tilled, 21 ac mown, 30 ac hay, 2 ac orchard, 8 cords wood							
1870 Wilkes Roper	140	25	4	300	0	225	30
1860 John Roper	90	30	6	175	4	80	18
1850 John Roper	90	36	500	1	150	20	
in 1850 addition: 1 horse, 2 oxen, 3 hogs, 25 bu wheat, 50 bu corn, 25 bu oats							
1850 Wilkes Roper	200	32	4	150	30	200	60
in 1850 addition: 2 horses, 4 oxen, 1 hogs, 28 bu wheat, 50 bu corn, 100 bu oats							
Mountain lot (537 ac)							
1860 John Brooks	145	572	14	150	20	25	
1850 J. Brooks	140	534	5	500	8	300	60
Parker pasture (32 ac)							
1860 D. Parker	275	31	6		12		
1850 D Parker	245	88	6		15		
Davis Pasture (57 ac on east of mountain)							
1860 R. Davis Jr.	380	100	25	2520	18	400	100
1860 R. Davis	250	50	6		40		
1850 R. Davis	250	20	5		40		

Table 4. Summary data from tree cores taken on Wachusett Mountain Massachusetts. Sources are coded as D: taken by Peter Dunwiddie 8 Aug 1995; C: taken by CVC Oct/Nov 1995; and P: taken by Chuck Pernaa 8 Nov 1995

(# -spp. -dbh(cm) -ring count-center*)

#	spp.	dbh(cm)	ring count-center*
Steep Toe			
D1	YB	81	180 rot
D2	RO	64	295 +
D3	SM	46	166 ±
D4	SM	53	177 ++
D5	RO	23	202 ++
C1	Be	36	127 =
C2	YB	52	97 Xrot
C9	YB	45	197 X
C10	Be	39	64 X rot
C11	SM	33	112±
Talus			
D6	YB	23	133 ++
D7	YB	27	192 ++
C12	YB	35	103 +
Brow			
C4	RO	52	206 ±
C5	Be	28	123 +
8A			
C8	RO	48	132 ±
C13	WA	38	126 ±
Hemlock 7-8			
C6	H	50	146Xrot
C7	H	30	121 +++
P2	H	?	240 ??
Lower edge			
D8	RO	40	202 ±
Spruce West of Indian Trail			
P2	RS	?	130 ?

---

* nearness of the core to pith (thus the degree that count underestimates actual age) is coded =: pith present; ±: nearly; +: close; ++: locatable; +++: very rough; Xrot: rotten center; X: broken off

Table 5. Composition, age and structure of forest stands on Wachusett Mountain. Field Work by Charles V. Cogbill on 18, 20 Oct and 2 Nov 1995. Additional data. from Lisa Standley, Peter Dunwiddie, and Chuck Pernaa (pers. comms).

site*	1	2	3	4	5	6
%BA	Toe	Trail	Talus	Brow	Hemlock	8A
red oak	9.3	20.0		41.7		58.1
beech	31.4	37.1		41.7		6.5
yellow birch	23.3	34.3	100	16.7	17.4	6.5
sugar maple	18.5	8.6				16.1
hemlock					82.6	
white ash						12.9
red maple	4.8					
striped maple	12.0					
mountain maple	0.9					
density t#/ha	960	148				
total area m2/ha	35.9		20.0	24.0	46.0	31.0
dead basal area	7.51		2.0	0.0	6.0	0.0
canopy height m	18.5		13.0	16.5	20.0	19.8
maximum size cm	82 YB	76YI	75 YB	72 RO	65 H	50 RO
median ring count	172+		133++	164+	146+++	132±

*1) steep **Toe** 5A 1670' 18° slope 20° mag azm permanent 20X50 m plot,
2) Standley 5A **Corridor** 1620-1840' 16 July 1995 tally of stems >30 cm
3) mid steep **Talus** slope on 5A 1720" >35° slope 2m BAF plot
4) upper **Brow** of mountain on 5A 1810' 12° slope 20° mag azm 2m BAF plot
5) upper **Hemlock** between 7 & 8 1700' 15° slope 20° mag azm 2m BAF plot
6) east of Oxbow **8A** 1500' 18° slope 30° mag azm 2X-2m BAF plots

Table 6. Approximate area of potential old growth forest within study area blocks. See Figure 2 for locations.

Block	Stand	Area	Total
West of Summit Lift	B1	14	
	L1	4.2	
	T1	9.2	
Block Total			27.4
Summit Lift/Trail 8	H1	6	
	B5	2.3	
	T3	1.5	
Block Total			9.8
Strip between Trail 5/7	B2	1.5	
	L2	0.9	
	T2	1.3	
Block Total			3.7
Islands in Trail 7	B3	0.4	
	B4	0.7	
Block Total			1.1
Strip between Trail 8/8A	H2	0.4	
	B6	4.3	
Block Total			4.7
East of Trail 8A	H3	1.4	
	B7	6.6	
Block Total			8
North of Down Road	H4	1.1	
	L3	2.9	
	T4	5.6	
Block Total			9.6

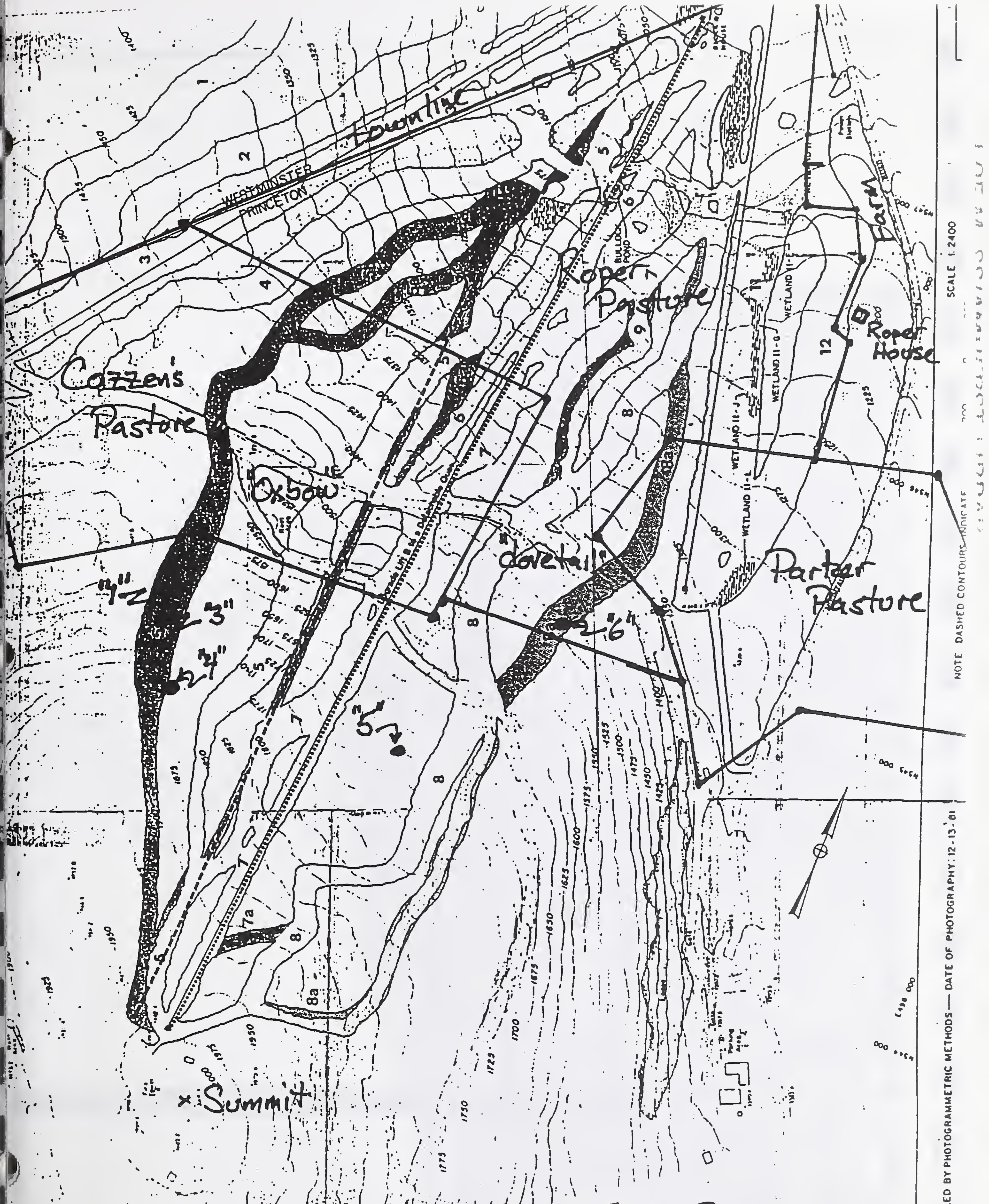
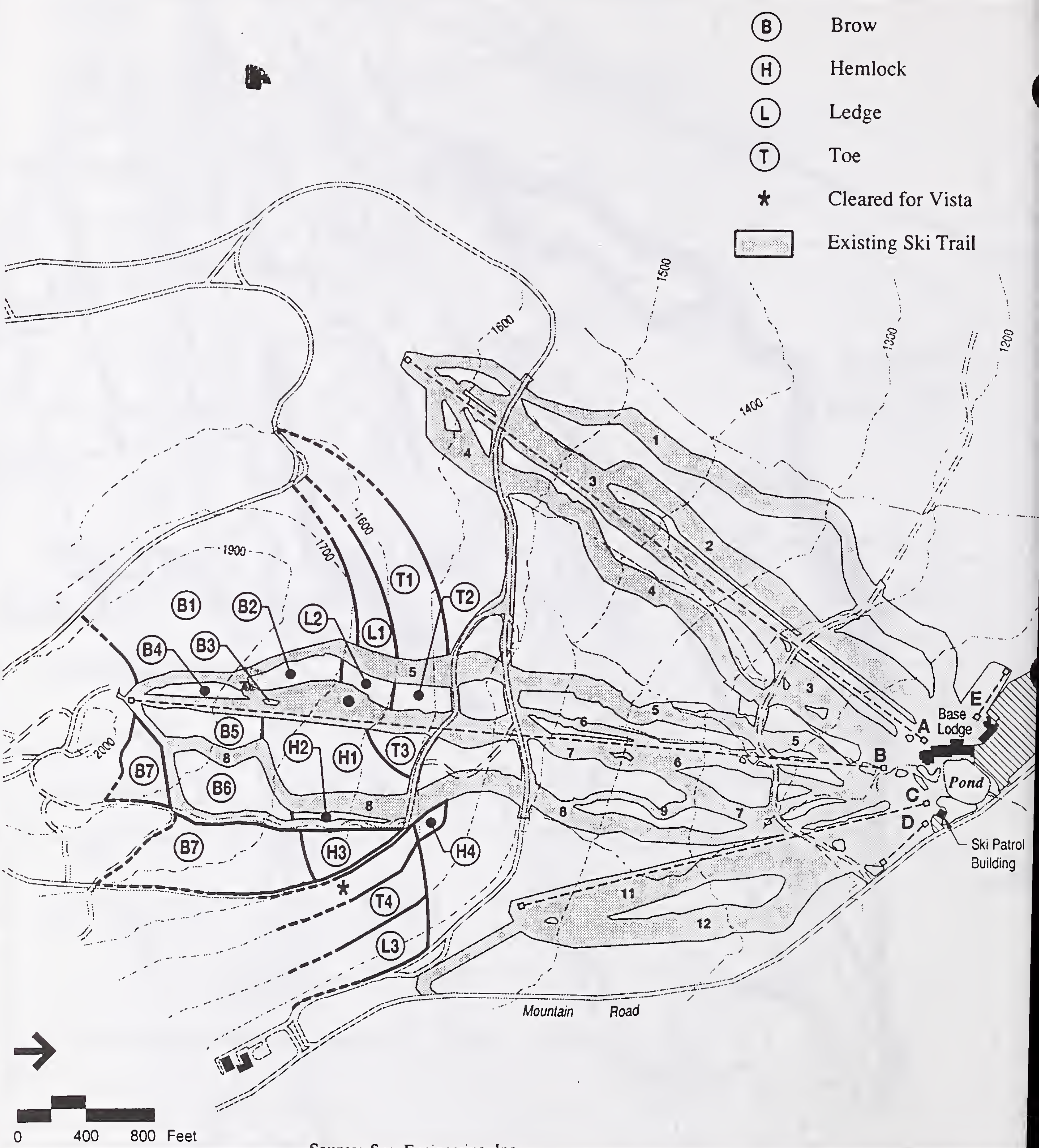


Fig 1. Base Map and Property Lines. Numbe



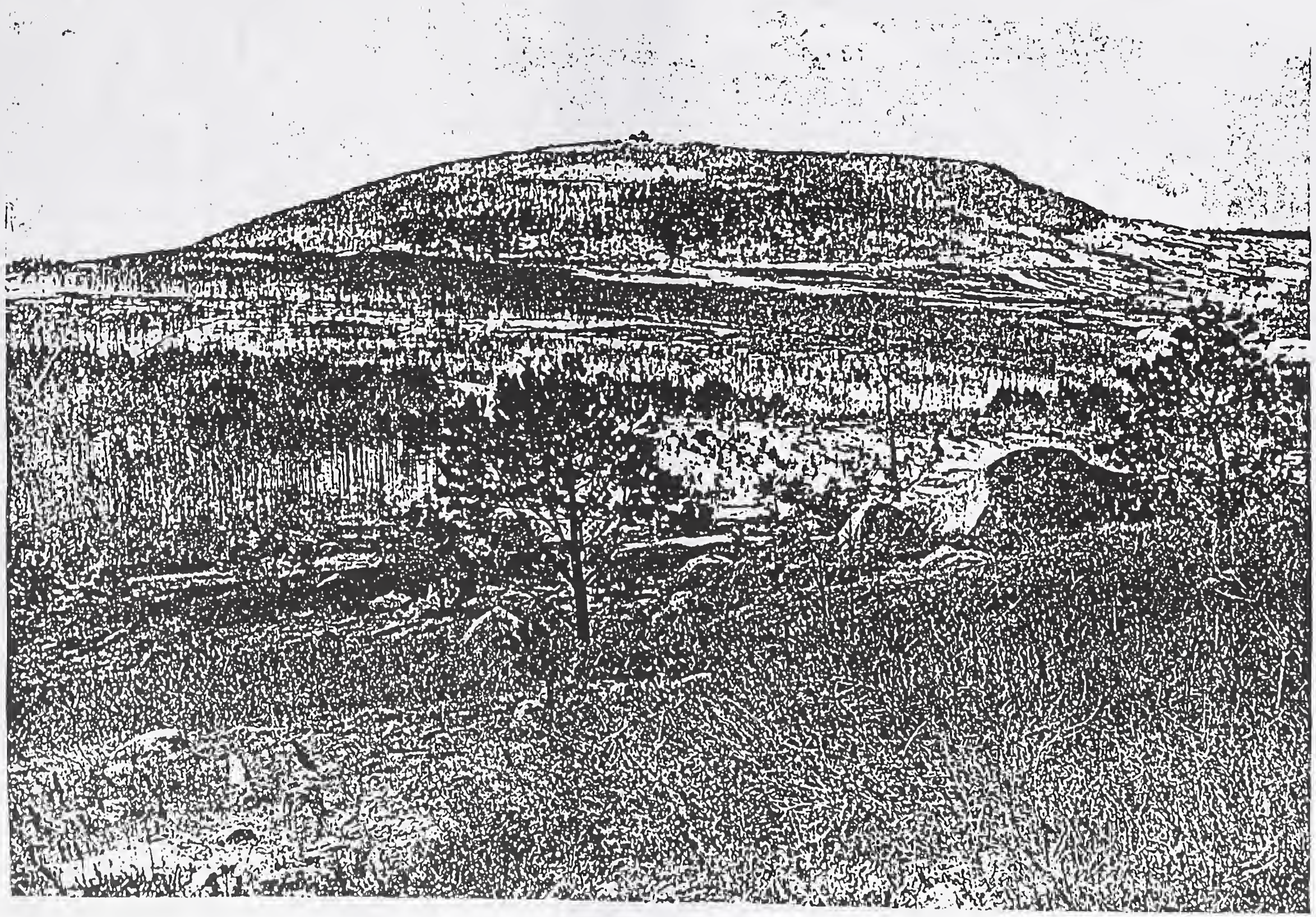
Source: Sno. Engineering, Inc.

Vanasse Hangen Brustlin, Inc.

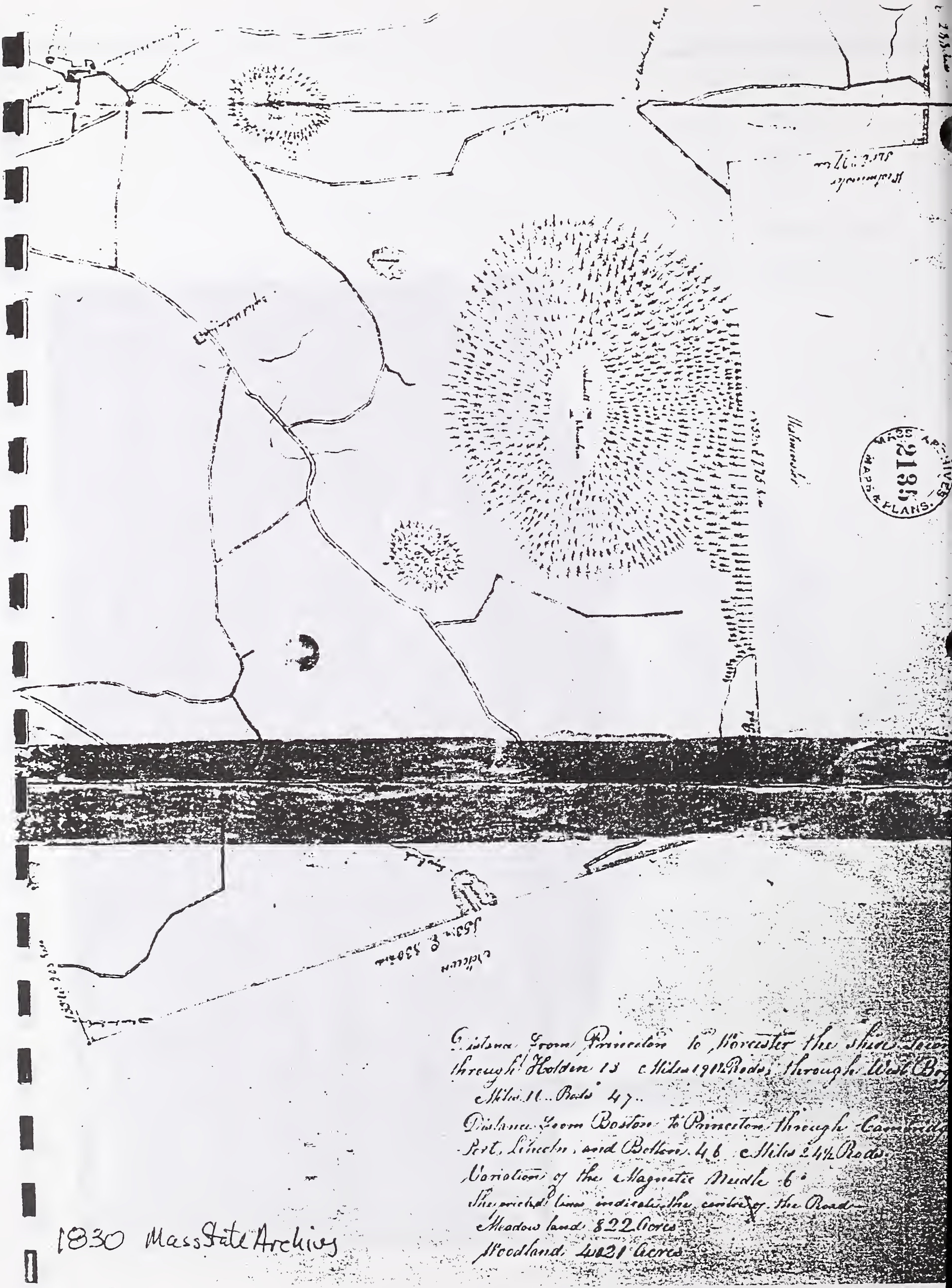
Locations of Stands Described in Table 6

Figure 2

1895 Kingsley & Knab



MOUNT WACHUSETT



Distance from Princeton to Worcester the shire Tow
through Holden 13 Miles 191½ Rods; through West Bo
Miles 11.. Rods 47..
Distance from Boston to Princeton through Cambridg
-Port, Lincoln, and Bolton. 46 Miles 24½ Rods.
Variation of the Magnetic Needle 6°
The pricked lines indicate the centre of the Road
Meadow land 822 Acres
Woodland 4021 Acres

1830 Mass State Archives

MASS ARCHIVES 2135 MAPS & PLANS

TREE CORE LAB DATA

Site: Wachusett Mt. MA

date read: Nov 95 by: CVC cored: CVC by:

base yr (1)=95

cores: fld notes	spp.	dbh cm	sap mm	hgt m	ring count	ctr ctn*	meas rib mm	ring # releases	thin yr	supp. yrs	notes	Growth (from cambium=0) mm length at year 5	10	20	50	100		200		300
BJ 3m S of [illegible]	YI	44.7	plot		176+[illegible]21	X	210 w/br	~135±	95-96	<12 vvs.p <52 sup		0.7	1.4	7.7	9.7	114.5	180			
BJ	E	39.0			64+	X	90	~25 V. gentle		38-50	rot	7.0	12.8	23.0	62.0					
MS below	SM	32.9			112	2	144	54** major rel	[illegible]		rel @ 30, [illegible]	13.8	20.6	39.8	98.7	134.7				
SW [illegible] upper edge	YI	35.0			103	3	152	76**	[illegible]	[illegible]		3.2	6.2	18.2	81.8	153				
												[illegible]	[illegible]	[illegible]	[illegible]					
Oct NE plot	Fugi	35.6	plot		127	1	160	~75 gnt	13,23,131 N		1690'	6.8	13.9	21.9	64.0	126.1				
Oct 1693'	Beal	51.9			97+	X	67.8	<4 rel		mucho 4 weak	hollow BP pla	4.9	6.5	11.8	25.1					
Oct 1620 edge slu	RO	54.4			120	2	220	[illegible]			edge into strch	8.0	15.7	25.5	69.2	161				
Oct top lvl 1920	RO	52.3			[illegible]4	1 9 year out	170	162**		168-180 W.	just outsil sti	3.8	7.9	16.4	43.9	88.7	154	158		
30 Oct top ldg	Fa[illegible]	27.4			123	3	125	~108		13-15?.51	E of [illegible] SA	2.5	4.6	10.6	43.9	106.6				
Oct W/B	H	50.0			71+73+ (108.7)	X ++	240+	48**	37-37**		"shaly"	10.2	23.6	39.4	86.5					
00 Oct W/B	H	30.5	–	–	121	4	120+		11-16 33,36,50	77-81		5.9	10.0	14.6	24.8	72.4			[illegible] 10	[illegible]
Oct 8A 1500'	RO	48.0		70'	132	~2-1	180		37 [illegible]	slowing ~10	13-15 faint 95-96 [illegible]	5.8	10.4	[illegible]	[illegible]	110.6			MA	R
Nov 8A	WA	37.9		60±	126	2-3	182	~49 ~78	66	49-56 78-86	slow 86	4.0	9.5	17.0	57.4	122.1				3

0=pith 1=arc closed 2=pith near 3=arc well bent 4=ctr locatable w/arc 5=passed by/way off X=broken/short

18 OCT. 1995
MT WACHUSETT
50x20 m PLOT - ACROSS SKI TRAIL 5A

AZIMUTH 25
E END SLOPE -18
+25
Small intermi stream
channel .5 GR
ROCKY BED

W END AZ. 15°
SLOPE -21
+25

CANOPY HEIGHT
BASELINE - 35 m
BUTT -17 %
CANOPY +36 %
BASE CANOPY +10 %

YB 42 46 5 / 82 (PARTIALLY CORED)

FAGUS 37 5 7 7 35 (1/3 CORKY GIRDLE) 15 7 9 7 1
16 34 15 8 44 (SCALE, 1/2 CORKY G) 6 7 5 7 1
14 5 9 24
40 (hollow) 31 39 37
26 (barely alive)
[40 NEAR

RO 65 (CORED II) [JUST OUTSIDE - 70] /

SUGAR 32 36 14 / 39 46 (CORED II) 16 9 17 8 (SNA
36 17

AC PEN 8 11 15 14 16 19 10 6
8 14 12 7 6 9 7 5
12 5 14 8 11 5 7 16 6
8 12 19 7 7 6 8 9 7
~~8~~ 18 20 11 18 7 7 6 17
7

AC RUB 38 27 (STOOL) /

AC SPIC 10 / 7 8 7 12

SOIL: 8 cm BROWN DUFF
8 cm DARK GREY ~ E
7 cm Red brown ~ BH
12 cm Yellow brown ~ B2
DRAINAGE MOTTLES @ 20 cm
above rock
VERY SCATTERED SMALL CHARCOAL
SLG
VERY ROCKY pH 4.4

DEADWOOD INVENTORY IN PLOTS

Date: 18 OCT

Wood > cm dbh originally rooted in of Plot:

Decay : has
0-foliage
1-twigs
2-med branches
3-bark hard
4-punky outside
5-punky thru
6-sag
7-lump
8-buried
9-hidden

Break: is
S-Splintered
B-brash
E-Even
R-Rough
P-sPired
F-fresh
I-discolored
D-dDcayed
C-Crumbling
G-Greenstick

Comments:
O-hOllow
A-heArtwood >>decay
W-sapWood >>decay
H-Hit by treefall

Uprooted:
PL-PLate
RB-Root Ball
BS-Ball & Socket

Standing Dead (some crown, give % if topped)

location	spp.	dbh (cm)	decay comments	location	spp.	dbh (cm)	decay comments
	AC PEN	8					
	AC PEN	8	2				
	AC PEN	11	3 RB				
	AC SPIC	6					
	AC PEN	12	3				

High Snap (bole break >bh)

location	spp.	dbh (cm)	hgt (m)	break fall->	decay	comments
B.	BEECH	25	5m		4	
	AC SAC	36	4m		5	SLOUGHING
	AC PEN	18	3 m		4	
	AC SAC	17	3 m		3	
LOW	AC PEN	10	1.3			
LOW	AC PEN	15			4	HIT BY BIRCH
LOW	AC PEN	15			4	BRANCHES

Low Snap (bole failure <2m)

location	spp.	dbh (cm)	hgt (m)	break fall->	decay	comments
	BEECH	30	0.6		3	
	AC PEN	~~4~~ -	~~4~~ -		3	
	AC PEN	~~6~~ -	~~B~~ -		3	
	AC SPIC	~~0.4~~ 22	0.1		4	
	AC SAC	30	.4		5	
	BET ALL	30	.6		6	
	AC SPIC	8	1.3		5	
	AC SPIC	9			4	
	FAC PEN	24			5	
	AC PEN	20			6	

Uprooted (root failure)

location	spp.	dbh (cm) tip type	fall->	decay	pit size (m)	mound hgt	comments
	AC PEN	9 RB	60				ERODED OUT
	FAGUS	37	70	4			ROOTS EXPOSED
	AC PEN	14	10				ROOTS in rock

Log/Stump (missing rest)

location	spp. dbh (cm)	type	length/hgt	run->	decay	comments
SEVERAL	oak STUMPS	D 8				
A						

APPENDIX C

Harvard Forest Reports (1996, 1997a, 1997b, 1999)

OLD-GROWTH FORESTS ON WACHUSETT MOUNTAIN

David A. Orwig, David R. Foster, and John F. O'Keefe
January 1999

INTRODUCTION

In 1995, a stand of old-growth forest was discovered on the upper northeast slope of the Wachusett Mountain State Reservation, within an area leased to Wachusett Mountain Associates and under consideration for a proposed ski trail. The discovery of the first old-growth forest east of the Connecticut River in Massachusetts, created widely divergent views on the significance and potential uses of the site and initiated a series of scientific studies examining the forests across the mountain. The following includes an overview of research conducted on the mountain since the initial discovery and provides recommendations for management and future research efforts.

PREVIOUS RESEARCH

Cogbill (1996) Historical report (prepared for Vanasse Hangen Brustlin, Inc.)

This report contained a lengthy review of the forest history and modern forest conditions of the area leased by Wachusett Mountain Associates including comprehensive historical documentation pertinent to understanding the range of natural environmental, factors, and land-use history that may have affected the Wachusett area historically and shaped its modern characteristics. Cogbill showed that the lower slopes on the mountain were formerly pastures and woodlots that currently contain young second-growth forest comprised of white pine and white ash. Additional historical documentation from the upper slopes, along with field studies led to the following conclusions related to the leased area: (1) forests across the elevational gradient were regularly disturbed and shaped by wind, snow, rain and ice-caused breakage, hurricane impact, slope instability and other disturbances; (2) vegetation types and stand characteristics are strongly influenced by bedrock geology, slope, soil depth, and exposure to wind, and ice damage, which are correlated with slope position; (3) four distinct stands were identified on the north slope (Toe, Ledge, Hemlock and Brow); (4) tree cores of the Toe site indicate a median age of 172 and maximum of 295 years, with red oak and yellow birch approaching their maximum age. Limited age data from the other communities suggest that: the Talus site has very old trees (median age >> 133 years on yellow birch) with little indication of disturbance, the Brow has oaks exceeding 200 years of age with some suggestions of ancient disturbance and one indication of 20th C selective logging, and the hemlock site has trees exceeding 240 years of age and "could have been used historically for tan bark at the approximate (time ~ 1860) of establishment of the youngest cored tree"; (5) the forests appear to exhibit little effect of bisection by the four ski trails, liftline and snowmaking pipelines, although the patches of forest between trails show some indication of edge effects roughly equal to one tree height. These results showed that WM did support stands of old-growth forest that were significant because of the wide range of vegetation types, the dominance of deciduous hardwood species, an unusual yellow birch talus community, the eastern Massachusetts location, and the relatively large increase that these areas make in the state total of old-growth forest. In addition, the structural characteristics of the forests and individual tree architectures increase the distinctiveness and value of these forests.

Foster et al. (1996) Harvard Forest Report (Overview and reconnaissance)

Three ecologists were invited by the Massachusetts Department of Environmental Management (DEM) to undertake a review of the old-growth forest area across DEM land on Wachusett Mountain (WM). This overview (1) provided a review of the Cogbill (1996) historical forest ecology report; (2) included extensive field reconnaissance to assess the extent and general age, structural, and compositional characteristics of old-growth forest areas within the reservation, including DEM land located outside the leased area; and (3) made recommendations for further, more detailed studies that would provide information on the developmental history, and long-term dynamics of the old-growth forest that would be pertinent to the oversight and management objectives of DEM.

The report was based on an introductory field excursion to Mount Wachusett with DEM personnel in November of 1995, two weeks of field studies conducted in the spring and early summer of 1996, interviews and discussion with Drs. Charlie Cogbill and Peter Dunwiddie [forest ecologists who have conducted the initial assessment of the forest for VHB and the Massachusetts Audubon Society, respectively), and extensive past experience in documenting and studying old-growth forest dynamics in New England and across northeastern North America.

Conclusions corroborated the Cogbill report and further identified and examined a large, intact area of old-growth forest that extended beyond the leased ski boundary and followed the steep upper contours of the mountain (above approx. 400 m a.s.l.). Reconnaissance of the upper slopes across most of the mountain indicated that sugar maple, yellow birch and red oak were commonly 150 to 250 years old, and that two red oak near the Old Indian Trail that were 285 and 307 years, respectively.

The total acreage of old growth forest outside of the leased area was estimated to be from 35 - 40 ha, making Wachusett Mountain one of the only old-growth sites east of the Connecticut River and the largest documented site in the state (Figure 1). Proposed additional research included evaluating the successional status and long-term forest stand dynamics of the study area by examining the age, structure, and composition of vegetation in concert with dendroecological patterns of young and old trees and coarse woody debris.

Foster et al. (1997a) Harvard Forest report (Impacts of proposed development)

In spring 1997 the Harvard Forest group accompanied personnel (Bill Rivers, Tom Lavoie, Chuck Pernaa, Joe Dombrow) from DEM to Mount Wachusett in order to discuss two proposed development activities: (1) relocation of many of the towers from the open summit area to an adjoining, lower forest area and erection of a communications building; and (2) development of a new trail extension (proposed trail 8A) off of trail 8 (Figure 2). The following section includes separate results and conclusions for each area.

(I) Summit area- The forest in the area of the proposed communications building site and south of the existing parking lot (Figure 2A) contained overstory red oak, American beech, red maple, and a few hemlock with diameters ranging from 15 - 50 cm dbh and heights of 6 - 12 m tall. Within the proposed building area seven trees were cored, primarily red oak with one beech and hemlock. Sizes ranged from 15 - 46 cm dbh and ages from 63 to 145 years old. Throughout the remainder of the area an additional thirteen trees were cored including one shagbark hickory. Trees ranged from 17 - 51 cm dbh and ages ranged from 84 to 187 years old. Although this area contained mature trees it lacked the very old trees that characterize the old growth forests covering large parts of the mountain. Presumably the area had experienced a history of disturbance by human activity (it contained several multiple-stemmed trees, indicative of past cutting and is located (100 - 300 m) from the open summit area, which contained a hotel beginning in the late 19th century) or natural disturbance in the last 200 years, and therefore did not meet the old-growth criteria of Cogbill (1996).

(II) Proposed Trail 8A expansion. The forest located between Up Summit Road and Down Summit Road (Figure 2C; 419 - 495 m a.s.l.) was comprised primarily of red oak, sugar maple, yellow birch, with a few patches of hemlock and white ash. Many trees in the stand exhibited old-growth characteristics and ranged from 30 - 78 cm dbh. Several of the trees exceeded 200 years of age, including a large red oak that was 285 years old. A dominant feature of this area was the scattered yellow birch in the 50 - 70 cm dbh range, estimated to be from 150 to over 300 years old. This upper portion of the proposed expansion contained many mature trees and does not appear to have been cut in the past.

In contrast, the area below Up Summit Road (Figure 2B; 373 - 427 m a.s.l.) exhibited characteristics of second-growth forests that were intensively disturbed in the past. Common overstory trees included red maple, yellow birch, black cherry, and white pine with a few scattered paper birch. The majority of trees were smooth-barked, multiple-stemmed individuals, indicative of past cutting. In addition, the area was bordered on two sides by stone walls, further evidence of past agricultural land use. This area was documented by Cogbill (1996) as the Parker Pasture, which was still active in the later half of the 19th Century. One of the larger white pines in the area was aged at 94 years.

Foster et al. (1997b) Harvard Forest report (Old-growth forest monitoring)

During the summers of 1996 and 1997, the Harvard Forest group intensively studied four distinct old-growth areas within the area administratively designated as old-growth in the Foster et al. (1996) report (Figure 3). The four areas designated on the figure do not represent stand or forest boundaries but merely the approximate location of permanent plots. Within each area, the age, structure, and composition of overstory vegetation was examined. The four old-growth areas were located on slopes > 20% at similar elevations of 427 - 518 m, but differed substantially in aspect, forest structure, and composition as follows:

Old Indian (OI) old-growth area: The overstory composition was comprised of a mixture of hardwood species including beech, red oak, red , sugar, and striped maples, and yellow birch. Thickets of mountain maple, striped maple and witch hazel were common in the sapling layer, and black bindweed and spinulose wood fern were the most common understory species. Structurally, red oaks were the oldest and largest trees in the stand, with several individuals > 64 cm dbh and exceeding 300 years old . Many beech and yellow birch were > 150 years old while the maple species were typically less than 100 years old and dominated the smaller size classes.

Eastern Talus (ET) old-growth area: Due to the abundance of rock boulders (talus), this forest had low basal areas and overstory stem densities. Yellow birch was the most abundant tree species on this site, although red oak and red maple were also common in the overstory. Mountain maple and striped maple were again found in dense sapling thickets and yellow birch saplings were also found in high abundance. Polypody was commonly found blanketing the rock surfaces on this site, along with wood ferns and sarsaparilla. A few large red oaks > 150 years old were interspersed among yellow birch representing a wide range of size and age classes. Many birch trees exceeded 250 years of age on this site, and the oldest tree found to date on the entire mountain (a yellow birch that was 369 years of age at breast height) was found here. Smaller individuals of striped and red maple have become established more recently at this site.

Southern Talus (ST) old-growth area: The site also contained large, scattered boulders and the overstory was dominated by red oak, red maple, and yellow birch . Due to the open, rocky nature of the site, witch hazel and striped maple were abundant in the sapling layer. The understory was comprised of many species, although only black bindweed, mountain aster, and sarsaparilla were locally abundant. Red oak represented the oldest and largest trees at this site, including several over 250 years old. A few beech, hickory, and sugar maple exceeded 200 years, while smaller-sized yellow birch and red maple were typically < 60 years old.

Hemlock (H) old-growth area: Shade-tolerant hemlock dominated this forest, although scattered individuals of red oak and a few other hardwoods were found throughout the stand. Due to the high density and basal area of hemlock, there was virtually no sapling layer and only a sparse understory layer of herbaceous species. Structurally, hemlock occurred across a broad range of size and age classes (20 - 71 cm dbh and 115 - 255 years old;). Many red oak and black birch trees exceeded 200 years in age and one red oak exceeded 300 years.

May (1998) Old-growth Lichen report

Dr. Philip May of the Farlow Herbarium in Cambridge, MA surveyed lichens at 9 sites on the mountain representing all habitat types and study areas mentioned in the Foster et al. (1997b) and Cogbill (1996) reports. This survey yielded much higher species diversity (150 species in 72 genera) than was found in well studied second-growth forests elsewhere in the state. Included in the list were 16 old-growth indicators from northern New England and several species rarely collected in Massachusetts, including one possibly new to science (*Rhizocarpon aff. anperum*). The presence of many unusual lichen species within these forests, despite possible negative effects from past air pollution, suggested that the mountain is serving as a lichen refugium.

SIGNIFICANCE OF RESOURCE

The forest composition and age-structure of trees found in the nearly continuous forest matrix on the upper slopes of Wachusett Mountain is extremely rare. Several trees found on the mountain including red oak, black birch, and yellow birch are at or very near the maximum longevity known for the species. Of particular significance is the number of red oak exceeding 250 - 300 years of age, which may be the most yet described anywhere in the eastern United States. In addition these forests have shed new insight into the appearance and structure of old-growth on harsh sites that does not meet typical expectations of cathedral-like groves of old-growth trees. The rocky, inaccessible upper slopes of the mountain are frequently exposed to wind and ice storms and have produced forests with distinct morphological characteristics including twisted, gnarled trees with stunted canopies that have persisted for several centuries. These stands represent some of the largest forests remaining from the presettlement landscape that have not been irrevocably altered due to catastrophic disturbances or European settlement clearing. In summary, Wachusett Mountain is an extremely interesting and ecologically significant site, particularly due to the close proximity of a wide range of forest types located at different aspects.

MANAGEMENT RECOMMENDATIONS

- All additional scientific study should require permission from DEM and any data stemming from such study should be housed in a secure archive and additional copies should be stored at the Wachusett Mountain Visitor's Center. Destructive sampling of plants or soil should be kept to a minimum.
- To reduce trampling effects on these steep slopes, large groups visiting old-growth areas should require a special-use permit from DEM and be limited to pre-existing trails. Exceptions could me made for small groups (a few individuals) with prior approval by DEM.
- Since these forests have remained intact for centuries, we recommend that no logging or salvage operations (live or dead trees) take place within the old-growth boundary, even following small- or large-scale disturbances or insect outbreaks such as the threatening hemlock woolly adelgid. Exceptions would include removal of hazard trees near roads or hiking and ski trails and maintaining scenic vistas that were historically cleared and currently do not contain old-growth trees.
- To reduce negative impacts from edge effects, further fragmentation within the administrative old-growth area should be discouraged.

FUTURE RESEARCH EFFORTS

Although a great deal has been learned through this research, several gaps still exist in our knowledge of these areas. We suggest that when appropriate funding is available, that additional studies be undertaken. Our recommendations for this work would include:

- GPS technology should be used to precisely locate each plot examined on the mountain and update the electronic version of the old-growth map. In addition, explicit directions to plot locations from well-established geographical points (e.g., trails, roads) should be stored at the Harvard Forest archives and at the Wachusett Mountain visitor's center.
- Follow-up re-sampling of permanent plots and other monitoring should take place at regular intervals to examine tree mortality levels and vegetation dynamics over time.
- Future sampling objectives should include a more formal survey of the flora of the reservation, including bryophytes, and spring ephemeral plants. In addition it would be useful to develop baseline information on wildlife populations within the old-growth areas.
- Additional areas within the original old-growth boundary that were only briefly examined should be intensively studied, such as the upper "islands" between ski trails, areas north beyond Harrington trail, the north slope red spruce stand, the southern slope above Echo Lake, and the area immediately south and southeast of the summit down to Down Summit Road.

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OLD-GROWTH FOREST MONITORING ON WACHUSETT MOUNTAIN

Final Report September 22, 1997

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In July 1996 the three authors from Harvard Forest submitted a final report on old-growth forests on Wachusett Mountain to the Massachusetts Department of Environmental Management (Foster *et al.* 1996). In summary, the report: (1) supported the comprehensive review of land-use history compiled by Dr. Charlie Cogbill (1996) for the leased ski area that identified strong land-use impacts on the lower slopes and summit of the mountain and documented the existence of protected areas of forest on the mid and upper slopes of the mountain that had been untouched by human activity but were subjected to strong natural stresses and disturbance; (2) confirmed the existence of a large, intact area of old-growth forest outside of the leased ski boundary of 75 to 100^{+} acres (30 - 40^{+} ha); (3) located many trees nearly 200 years of age and over a dozen exceeding that age; and (4) recommended further work to clarify the extent and patchiness of old forest, the disturbance history and overall forest dynamics.

During the summers of 1996 and 1997, the Harvard Forest group intensively studied four distinct old-growth areas within the area administratively designated as old-growth in the 1996 report (Figure 1).* The four areas designated on the figure do not represent stand or forest boundaries but merely the approximate location of permanent plots. Within each area, we examined the age, structure, and composition of overstory vegetation in concert with an analysis of understory vegetation. Vegetation was sampled in five, 66 X 66 ' (20 X 20 m) plots established along transects in designated old-growth stands. Plots were spaced at approximately 70 ' (21 m) intervals oriented through representative portions of designated old-growth areas and plot corners will be permanently marked with iron pipe. Slope, aspect, and topographic position were recorded at each plot. In addition, the species and diameter at breast height (dbh) were recorded for each stem ≥ 4.5 ' (1.4 m) tall and with a dbh ≥ 3 " (8 cm). Within each old-growth area, a relative importance value was calculated for each species by summing relative density and relative dominance (basal area) and dividing by two. All saplings (stems > 4.5 ' tall and < 3 " dbh) were counted by species and seedling (stems < 4.5 ' tall), shrub, and herbaceous cover (%) were estimated within each overstory plot.

*To protect Old Growth Forest resources, the location of permanent monitoring plots has been omitted. This information is available by Special Permit from DEM Region 3 Headquarters for approved scientific research.

Two to four trees spanning all species and size classes were randomly selected and cored at 4.5 ' with increment borers for radial growth analysis and age determinations in each plot. Additional cores outside of overstory plots were obtained to enhance the long-term record of dynamics in each old-growth area. All increment cores were stored in plastic straws and transported to Harvard Forest for examination. Cores were air dried, mounted, sanded, and aged with a dissecting microscope. Ring widths were measured with a VELMEX (East Bloomfield, NY) measuring system.

Results

The four old-growth areas were located on slopes > 20% at similar elevations of 1400 - 1700 ' (427 - 518 m), but differed substantially in aspect, forest structure, and composition (Table 1). Therefore, each of the old-growth areas will be described separately, followed by a synopsis of significant findings.

Old Indian (OI) old-growth area: This area was located on the northern aspect of Wachusett Mountain just south of the oxbow area and just west of current ski trail # 5 (Figure 1). The overstory composition was comprised of a mixture of hardwood species including beech, red oak, red , sugar, and striped maples, and yellow birch (Table 1). Thickets of mountain maple, striped maple and witch hazel were common in the sapling layer (Table 2), and black bindweed and spinulose wood fern were the most common understory species (Table 3). Structurally, red oaks were the oldest and largest trees in the stand, with several individuals > 25 " (64 cm) dbh and exceeding 300 years old (Table 4). Many beech and yellow birch were > 150 years old while the maple species were typically less than 100 years old and dominated the smaller size classes.

Eastern Talus (ET) old-growth area: This area was located on steep, rocky slopes near the eastern boundary of the reservation above the visitor's center parking lot (Figure 1). Due to the abundance of rock boulders (talus), this forest had low basal areas and overstory stem densities (Table 1). Yellow birch was the most abundant tree species on this site, although red oak and red maple were also common in the overstory (Table 1). Mountain maple and striped maple were again found in dense sapling thickets and yellow birch saplings were also found in high abundance (Table 2). Polypody was commonly found blanketing the rock surfaces on this site, along with wood ferns and sarsaparilla (Table 5). A few large red oaks > 150 years old were interspersed among yellow birch representing a wide range of size and age classes (Table 6). Many birch trees exceeded 250 years of age on this site, and the oldest tree found to date on the entire mountain (a yellow birch that was 369 years of age at breast height) was found here.

Smaller individuals of striped and red maple have become established more recently at this site.

Southern Talus (ST) old-growth area: This area was located southeast of the summit, below Down Summit Road. The site also contained large, scattered boulders and the overstory was dominated by red oak, red maple, and yellow birch (Table 1). Due to the open, rocky nature of the site, witch hazel and striped maple were abundant in the sapling layer (Table 2). The understory was comprised of many species, although only black bindweed, mountain aster, and sarsaparilla were locally abundant (Table 7). Red oak represented the oldest and largest trees at this site, including several over 250 years old. A few beech, hickory, and sugar maple exceeded 200 years, while smaller-sized yellow birch and red maple were typically < 60 years old (Table 8).

Hemlock (H) old-growth area: This area was located south of the summit on the western slope of the mountain "hump" (Figure 1). Shade-tolerant hemlock dominated this forest, although scattered individuals of red oak and a few other hardwoods were found throughout the stand (Table 1). Due to the high density and basal area of hemlock, there was virtually no sapling layer and only a sparse understory layer of herbaceous species (Table 2, 9). Structurally, hemlock occurred across a broad range of size and age classes (8 - 28 " (20 - 71 cm) dbh; 115 - 255 years old; Table 10). Many red oak and black birch trees exceeded 200 years in age and one red oak exceeded 300 years.

Discussion

The forest composition and age-structure of trees found in these four areas is extremely rare. Several trees found on the mountain including red oak, black birch, and yellow birch are at or very near the maximum longevity known for the species. Of particular significance is the number of red oak exceeding 250 - 300 years of age, which may be the most yet described anywhere in the eastern United States. We have gained insight into the appearance and structure of old-growth on harsh sites that would not have met most typical expectations of what old-growth looks like. The rocky, inaccessible upper slopes of the mountain are frequently exposed to wind and ice storms and have produced forests of stunted, gnarled trees that have persisted for several centuries. In summary, Wachusett Mountain is an extremely interesting and ecologically significant site, particularly due to the wide range of forest types located at different aspects, each containing a high percentage of mature hardwood species.

Proposed future research

Although a great deal has been learned through this research, several gaps still exist in our knowledge of these areas. We suggest that when appropriate funding is available, that additional studies be undertaken. Our recommendations for this work would include:

- All data and tree cores will be archived in the Harvard Forest archives for preservation and future research.
- We intend to incorporate the information contained in this report with historical information obtained by Cogbill (1996) and more extensive dendroecological analyses into a manuscript that will be submitted for publication in an ecological journal.
- When technology becomes available, we will use a GPS unit to precisely locate each plot examined on the mountain and update the electronic version of the old-growth map. In addition, explicit directions to plot locations from well-established geographical points (e.g., trails, roads) will be stored at the Harvard Forest archives and at the Wachusett Mountain visitor's center.
- Future sampling objectives may include fungi, lichens, bryophytes, and spring ephemeral plants since these were not included in this study. In addition there has been no specific monitoring of wildlife in these areas. Finally, we did not extensively sample the entire area within the original old-growth boundary, such as the upper "islands" between ski trails, areas north beyond Harrington trail, and the area immediately south and southeast of the summit down to Down Summit Road.

Literature Cited

Cogbill, C.V. 1996. An assessment of the historical ecology of the forests on the northeast slope of Wachusett Mountain, Massachusetts. Report prepared by Vanasse Hangen Brustlin, Inc. for Wachusett Mountain Associates.

Foster, D.R., D.A. Orwig, and J. O'Keefe. 1996. Final report on old-growth forests on Wachusett Mountain. Report comminssioned by the Massachusetts Department of Environmental Management.

Table 1. Overstory species relative importance values* and general stand characteristics within the 4 sampled old-growth areas on Wachusett Mountain, Massachusetts.

Species	Old Indian	Eastern Talus	Southern Talus	Hemlock
American Beech	22.1	--	9.0	--
Eastern hemlock	--	--	--	70.4
Hornbeam (*Ostrya*)	1.3	2.4	4.0	--
Red oak	18.9	18.9	29.4	13.4
Red maple	15.8	16.3	22.0	4.6
Striped maple	14.1	6.2	2.1	--
Sugar maple	12.8	1.9	5.1	--
Yellow birch	12.7	45.4	23.4	3.4
Other species	2.4	12.5	4.9	8.2
Total Density/Acre	190	156	239	239
(ha^{-1})	470	385	590	590
Basal area ($ft.^2$/Acre)	148.1	76.7	118.9	266.6
(m^2/ha)	34.0	17.6	27.3	61.2
Elevation (')	1600 - 1750	1410 - 1525	1600 - 1680	1538 - 1620
(m a.s.l.)	488 - 533	430 - 465	488 - 512	469 - 494
Aspect	N - NW	E	SE - S	W
Slope (%)	20 - 40	35 - 40	35 - 40	30 - 40

*Importance values were calculated by species as: (Relative density + Relative basal area)/2

Table 2a. Sapling density (per acre) within the 4 sampled old-growth areas on Wachusett Mountain, Massachusetts.

Species	Old Indian	Eastern Talus	Southern Talus	Hemlock
American beech	117	--	45	--
Hornbeam *(Ostrya)*	2	2	22	--
Mountain ash	4	30	2	--
Mountain maple	184	249	77	--
Red oak	—	4	10	--
Red maple	24	6	43	--
Striped maple	235	196	223	8
Sugar maple	18	10	18	--
Witch hazel	132	81	360	--
Yellow birch	12	146	85	--
Other	6	81	14	20
Total	734	805	899	28

Table 2b. Sapling density (ha^{-1}) within the 4 sampled old-growth stands on Wachusett Mountain, Massachusetts.

Species	Old Indian	Eastern Talus	Southern Talus	Hemlock
American beech	290	--	110	--
Hophornbeam *(Ostrya)*	5	5	55	--
Mountain ash	10	75	5	--
Mountain maple	455	615	190	--
Red oak	—	10	25	--
Red maple	60	15	105	--
Striped maple	580	485	550	20
Sugar maple	45	25	45	--
Witch hazel	325	200	890	--
Yellow birch	30	360	210	--
Other	15	200	35	50
Total	1815	1990	2220	70

Table 3. Mean cover (% ± S.E.) of understory vegetation within 66 X 66' plots in the Old Indian old-growth area on Wachusett Mountain.

Species	Cover
Bellwort	0.5 ± 0.0
Black bindweed	20.7 ± 16.9
Blue bead lily	1.0 ± 0.5
Canada mayflower	0.1 ± 0.1
Chokecherry	0.1 ± 0.1
Currant (gooseberry)	3.1 ± 3.0
Dwarf raspberry	0.2 ± 0.2
Elderberry	1.0 ± 0.5
Grass species	0.3 ± 0.1
Hobblebush	3.0 ± 0.0
Honeysuckle species	0.4 ± 0.1
Indian cucumber	0.1 ± 0.1
Jack in the pulpit	0.1 ± 0.1
Marginal wood fern	3.4 ± 2.9
Mountain aster	4.4 ± 2.7
Raspberry	0.2 ± 0.1
Sarsaparilla	2.0 ± 0.6
Shining clubmoss	0.2 ± 0.1
Soloman's seal (hairy)	0.2 ± 0.1
Spinulose wood fern	24.7 ± 12.5
Starflower	0.4 ± 0.1
Trillium	0.2 ± 0.1
Twisted stalk	0.4 ± 0.1
Violet species	0.2 ± 0.1
Virginia creeper	0.1 ± 0.1
White wood aster	0.2 ± 0.1
Wood sorrel	0.8 ± 0.6

Table 4a. Size and age structure of trees cored within the Old Indian old-growth area on Wachusett Mountain.

Species	DBH (")	Age
Beech	18.0	236
Beech	12.3	138
Beech	8.0	109
Beech	3.1	108
Beech	5.9	103
Beech	15.4	110
Beech	12.2	154
Beech	13.2	134
Beech	16.3	190
Beech	18.0	188
Beech	6.1	145
Ostrya	7.2	164
Ostrya	8.8	167
Ostrya	4.5	89
Red maple	13.7	192
Red maple	19.1	154
Red maple	14.8	94
Red maple	7.7	71
Red maple	4.8	38
Red maple	4.3	36
Red oak	30.0	322
Red oak	23.6	320
Red oak	25.6	320
Red oak	23.5	307
Red oak	20.9	305
Red oak	28.3	287
Red oak	20.5	210
Red oak	19.1	207
Red oak	21.3	198
Red oak	20.2	194
Red oak	22.0	189
Red oak	16.8	170
Red oak	21.8	232
Sugar maple	20.7	207
Sugar maple	21.0	90
Sugar maple	4.7	66
Sugar maple	3.3	41
Sugar maple	15.2	141
Sugar maple	26.7	146
Sugar maple	11.1	113
Sugar maple	8.7	48
Striped maple	5.9	52
Striped maple	6.4	51
Striped maple	5.9	45
Striped maple	3.7	39
Striped maple	4.7	37
Striped maple	7.3	35
Striped maple	4.7	29
Striped maple	4.4	29
White ash	21.1	183
Witch hazel	4.3	45
Yellow birch	14.3	186
Yellow birch	25.3	181
Yellow birch	21.4	171
Yellow birch	22.4	154
Yellow birch	10.2	51
Yellow birch	16.1	127
Yellow birch	21.5	150

Table 4b. Size and age structure of trees cored within the Old Indian old-growth area on Wachusett Mountain.

Species	DBH (cm)	Age
Beech	45.6	236
Beech	31.2	138
Beech	20.2	109
Beech	8.0	108
Beech	15.1	103
Beech	39.1	110
Beech	30.9	154
Beech	33.5	134
Beech	41.3	190
Beech	45.6	188
Beech	15.6	145
Ostrya	18.3	164
Ostrya	22.4	167
Ostrya	11.5	89
Red maple	34.9	192
Red maple	48.5	154
Red maple	37.6	94
Red maple	19.5	71
Red maple	12.3	38
Red maple	10.8	36
Red oak	76.3	322
Red oak	59.9	320
Red oak	64.9	320
Red oak	59.7	307
Red oak	23.0	305
Red oak	71.9	287
Red oak	52.1	210
Red oak	48.6	207
Red oak	54.0	198
Red oak	51.2	194
Red oak	56.0	189
Red oak	42.6	170
Red oak	55.3	232
Sugar maple	52.6	207
Sugar maple	53.4	90
Sugar maple	11.9	66
Sugar maple	8.4	41
Sugar maple	38.6	141
Sugar maple	67.8	146
Sugar maple	28.2	113
Sugar maple	22.0	48
Striped maple	15.1	52
Striped maple	16.3	51
Striped maple	15.1	45
Striped maple	9.3	39
Striped maple	11.9	37
Striped maple	18.6	35
Striped maple	12.0	29
Striped maple	11.1	29
White ash	53.7	183
Witch hazel	10.8	45
Yellow birch	36.3	186
Yellow birch	64.2	181
Yellow birch	54.3	171
Yellow birch	56.8	154
Yellow birch	25.9	51
Yellow birch	40.9	127
Yellow birch	54.5	150

Table 5. Mean cover (% ± S.E.) of understory vegetation within 66 X 66' plots in the Eastern Talus old-growth area on Wachusett Mountain

Species	Cover
Black bindweed	1.0 ± 0.5
Blue bead lily	0.1 ± 0.1
Currant (gooseberry)	1.0 ± 0.5
Canada mayflower	0.1 ± 0.1
Christmas fern	0.1 ± 0.1
Elderberry	0.3 ± 0.1
Fragile fern	0.1 ± 0.1
Jack in the pulpit	0.3 ± 0.1
Marginal wood fern	3.9 ± 2.8
Mountain aster	0.5 ± 0.0
Poison ivy	0.1 ± 0.1
Polypody	35.1 ± 9.1
Raspberry species	3.4 ± 2.9
Rosy bells	0.1 ± 0.1
Sarsaparilla	8.4 ± 7.3
Sedge species	0.5 ± 0.2
Spinulose wood fern	3.9 ± 2.8
Virginia creeper	0.3 ± 0.1

Table 6a. Size and age structure of trees cored within the Eastern Talus old-growth area on Wachusett Mountain.

Species	DBH (")	Age
Black birch	13.2	61
Hemlock	32.9	190
Hemlock	32.1	116
Hophornbeam	8.0	92
Hophornbeam	5.3	75
Mountain ash	7.6	33
Red maple	11.7	50
Red maple	9.0	93
Red maple	12.5	94
Red maple	4.9	52
Red maple	3.9	27
Red maple	5.4	51
Red oak	16.9	77
Red oak	18.7	215
Red oak	26.4	186
Red oak	23.1	160
Red oak	20.8	121
Red oak	23.5	146
Red oak	21.1	171
Red oak	24.5	163
Red oak	23.6	182
Red oak	18.4	190
Red oak	21.8	222
Red oak	19.9	173
Red oak	29.1	103
Red oak	25.4	87
Red oak	33.2	86
Red spruce	17.2	114
Shag. hickory	8.4	114
Sugar maple	7.4	53
Striped maple	5.7	35
Striped maple	4.1	38
White ash	21.1	124
White ash	5.3	32
White ash	8.1	38
Yellow birch	18.1	168
Yellow birch	18.9	168
Yellow birch	20.2	256
Yellow birch	19.4	147
Yellow birch	5.1	34
Yellow birch	7.3	47
Yellow birch	4.4	27
Yellow birch	20.6	169
Yellow birch	5.9	20
Yellow birch	20.8	212
Yellow birch	19.2	215
Yellow birch	27.6	162
Yellow birch	14.8	175
Yellow birch	24.3	169
Yellow birch	21.7	178
Yellow birch	21.0	153
Yellow birch	18.3	230
Yellow birch	17.1	204
Yellow birch	17.1	116
Yellow birch	4.0	17
Yellow birch	15.6	157
Yellow birch	5.5	30
Yellow birch	9.6	28
Yellow birch	5.0	41
Yellow birch	20.2	214
Yellow birch	21.1	169
Yellow birch	19.7	180
Yellow birch	19.1	369
Yellow birch	17.4	240
Yellow birch	19.5	177
Yellow birch	21.9	90

Table 6b. Size and age structure of trees cored within the Eastern Talus old-growth area on Wachusett Mountain.

Species	DBH (cm)	Age
Black birch	33.6	61
Hemlock	83.5	190
Hemlock	81.5	116
Hophornbeam	20.2	92
Hophornbeam	13.4	75
Mountain ash	19.4	33
Red maple	29.8	50
Red maple	22.9	93
Red maple	31.8	94
Red maple	12.4	52
Red maple	9.8	27
Red maple	13.7	51
Red oak	42.9	77
Red oak	47.6	215
Red oak	67.1	186
Red oak	58.8	160
Red oak	52.9	121
Red oak	59.6	146
Red oak	53.6	171
Red oak	62.3	163
Red oak	60.0	182
Red oak	46.8	190
Red oak	55.3	222
Red oak	50.5	173
Red oak	73.9	103
Red oak	64.5	87
Red oak	84.3	86
Red spruce	43.8	114
Shag. hickory	21.3	114
Sugar maple	18.9	53
Striped maple	14.4	35
Striped maple	10.5	38
White ash	53.5	124
White ash	13.4	32
White ash	20.7	38
Yellow birch	46.0	168
Yellow birch	47.9	168
Yellow birch	51.3	256
Yellow birch	49.3	147
Yellow birch	12.9	34
Yellow birch	18.5	47
Yellow birch	11.1	27
Yellow birch	52.2	169
Yellow birch	15.0	20
Yellow birch	52.9	212
Yellow birch	48.7	215
Yellow birch	70.1	162
Yellow birch	37.7	175
Yellow birch	61.6	169
Yellow birch	55.2	178
Yellow birch	53.3	153
Yellow birch	46.4	230
Yellow birch	43.5	204
Yellow birch	43.5	116
Yellow birch	10.2	17
Yellow birch	39.6	157
Yellow birch	14.0	30
Yellow birch	24.5	28
Yellow birch	12.7	41
Yellow birch	51.3	214
Yellow birch	53.5	169
Yellow birch	50.0	180
Yellow birch	48.6	369
Yellow birch	44.2	240
Yellow birch	49.5	177
Yellow birch	55.6	90

Table 7. Mean cover (% ± S.E.) of understory vegetation within 66 X 66' plots in the Southern Talus old-growth area on Wachusett Mountain.

Species	Cover
Azalea species	0.3 ± 0.1
Black bindweed	3.3 ± 2.9
Blueberry species	0.4 ± 0.1
Blue bead lily	0.9 ± 0.5
Currant (gooseberry)	0.8 ± 0.6
Canada mayflower	0.8 ± 0.6
Christmas fern	0.2 ± 0.1
Clubmoss species	0.1 ± 0.1
Elderberry	0.5 ± 0.0
False solomon's seal	0.4 ± 0.1
Rough stemmed goldenrod	0.3 ± 0.1
Hay scented fern	0.3 ± 0.1
Indian cucumber	0.1 ± 0.1
Interrupted fern	0.1 ± 0.1
Jack in the pulpit	0.5 ± 0.0
Marginal wood fern	0.5 ± 0.0
Mountain aster	4.4 ± 2.7
New York fern	0.1 ± 0.1
Poison ivy	0.1 ± 0.1
Polypody	0.2 ± 0.1
Raspberry species	0.3 ± 0.1
Sarsaparilla	3.8 ± 2.8
Sedge species	0.3 ± 0.1
Solomon's seal (rough)	0.4 ± 0.1
Spinulose wood fern	0.5 ± 0.0
Starflower	0.8 ± 0.6
Trillium	0.3 ± 0.1
Twisted stalk	0.4 ± 0.1
Virginia creeper	0.3 ± 0.1
White wood aster	0.3 ± 0.1
Wood anemone	0.1 ± 0.1

Table 8a. Size and age structure of trees cored within the Southern Talus old-growth area on Wachusett Mountain.

Species	DBH (")	Age
Beech	25.2	156
Beech	17.4	181
Beech	20.0	217
Hophornbeam	4.1	74
Pignut hickory	9.6	226
Red maple	8.5	51
Red maple	5.0	45
Red maple	6.9	68
Red maple	10.1	90
Red maple	9.1	101
Red maple	4.9	54
Red maple	9.7	52
Red maple	3.2	36
Red oak	19.8	203
Red oak	24.9	144
Red oak	30.5	262
Red oak	14.9	149
Red oak	19.1	190
Red oak	24.5	151
Red oak	20.7	170
Red oak	20.8	196
Red oak	20.2	219
Red oak	15.3	202
Red oak	23.8	208
Red oak	29.9	252
Red oak	14.8	209
Red oak	18.2	192
Red oak	20.9	188
Red oak	26.0	199
Red oak	19.0	126
Red oak	20.8	196
Red oak	28.9	252
Red oak	19.3	203
Red oak	26.9	112
Red oak	11.1	98
Red oak	9.3	101
Red oak	4.8	24
Red oak	21.0	192
Red oak	17.7	217
Shag. hickory	11.5	150
Sugar maple	17.7	81
Sugar maple	19.3	151
Sugar maple	22.1	149
Sugar maple	8.5	36
Sugar maple	11.9	159
Striped maple	3.7	56
Striped maple	3.9	27
Striped maple	6.5	28
Striped maple	4.2	25
White ash	6.2	54
Yellow birch	10.6	26
Yellow birch	15.5	88
Yellow birch	16.4	120
Yellow birch	17.9	85
Yellow birch	20.4	106
Yellow birch	10.6	51
Yellow birch	9.1	56
Yellow birch	9.2	54
Yellow birch	5.6	24
Yellow birch	6.2	72
Yellow birch	10.6	77
Yellow birch	16.2	157
Yellow birch	17.9	166
Yellow birch	5.6	25
Yellow birch	23.1	165

Table 8b. Size and age structure of trees cored within the Southern Talus old-growth area on Wachusett Mountain.

Species	DBH (cm)	Age
Beech	64.1	156
Beech	44.1	181
Beech	50.8	217
Hophornbeam	10.4	74
Pignut hickory	24.3	226
Red maple	21.6	51
Red maple	12.8	45
Red maple	17.4	68
Red maple	25.7	90
Red maple	23.0	101
Red maple	12.4	54
Red maple	24.7	52
Red maple	8.1	36
Red oak	50.4	203
Red oak	63.2	144
Red oak	77.4	262
Red oak	37.8	149
Red oak	48.4	190
Red oak	62.2	151
Red oak	52.7	170
Red oak	52.9	196
Red oak	51.4	219
Red oak	38.9	202
Red oak	60.4	208
Red oak	76.0	252
Red oak	37.7	209
Red oak	46.2	192
Red oak	53.0	188
Red oak	66.0	199
Red oak	48.3	126
Red oak	52.1	196
Red oak	73.3	252
Red oak	48.9	203
Red oak	68.2	112
Red oak	28.1	98
Red oak	23.5	101
Red oak	12.2	24
Red oak	53.3	192
Red oak	44.9	217
Shag. hickory	29.2	150
Sugar maple	45.0	81
Sugar maple	49.1	151
Sugar maple	56.2	149
Sugar maple	21.7	36
Sugar maple	30.2	159
Striped maple	9.4	56
Striped maple	10.0	27
Striped maple	16.6	28
Striped maple	10.7	25
White ash	15.7	54
Yellow birch	26.8	26
Yellow birch	39.3	88
Yellow birch	41.7	120
Yellow birch	45.4	85
Yellow birch	51.7	106
Yellow birch	26.9	51
Yellow birch	23.1	56
Yellow birch	23.3	54
Yellow birch	14.3	24
Yellow birch	15.7	72
Yellow birch	26.8	77
Yellow birch	41.1	157
Yellow birch	45.5	166
Yellow birch	14.1	25
Yellow birch	58.6	165

Table 9. Mean cover (% ± S.E.) of understory vegetation within 66 X 66' plots in the Hemlock old-growth area on Wachusett Mountain.

Species	Cover
Bellwort	0.5 ± 0.0
Blue bead lily	0.5 ± 0.0
Blueberry species	0.4 ± 0.1
Canada mayflower	0.5 ± 0.0
Grass species	0.1 ± 0.1
Hobblebush	0.3 ± 0.1
Honeysuckle species	0.5 ± 0.0
Indian cucumber	0.1 ± 0.1
Marginal wood fern	0.5 ± 0.0
Mountain aster	1.0 ± 0.5
Polypody	0.4 ± 0.1
Rosy bells	0.4 ± 0.1
Sarsaparilla	0.4 ± 0.1
Starflower	0.4 ± 0.1
Spinulose wood fern	0.2 ± 0.1
White wood aster	0.2 ± 0.1

Table 10a. Size and age structure of trees cored within the Hemlock old-growth area on Wachusett Mountain.

Species	DBH (")	Age
Black birch	17.3	238
Black birch	8.5	151
Black birch	18.6	198
Black birch	10.4	159
Black birch	20.7	212
Hemlock	11.2	189
Hemlock	16.0	146
Hemlock	22.0	192
Hemlock	17.0	217
Hemlock	21.1	211
Hemlock	12.1	163
Hemlock	18.9	207
Hemlock	27.5	255
Hemlock	19.4	176
Hemlock	28.0	180
Hemlock	33.4	219
Hemlock	12.8	180
Hemlock	25.4	173
Hemlock	26.9	158
Hemlock	13.0	174
Hemlock	9.4	195
Hemlock	14.3	205
Hemlock	20.0	210
Hemlock	18.9	196
Hemlock	25.4	157
Hemlock	19.8	245
Hemlock	12.0	159
Hemlock	10.4	162
Hemlock	25.3	165
Hemlock	13.5	115
Hemlock	9.6	137
Hemlock	8.0	166
Hemlock	19.8	170
Hemlock	15.9	183
Hemlock	16.0	177
Hemlock	13.7	210
Hemlock	13.7	180
Hemlock	10.0	185
Hemlock	15.8	175
Hemlock	17.3	200
Hemlock	9.8	160
Hemlock	16.2	183
Hemlock	22.8	179
Hemlock	24.0	187
Hemlock	25.1	243
Hemlock	22.2	197
Hemlock	18.5	201
Hemlock	19.4	238
Hemlock	23.7	147
Red maple	11.9	134
Red maple	8.6	104
Red maple	19.0	123
Red maple	10.2	104
Red oak	18.5	191
Red oak	22.4	204
Red oak	22.8	305
Red oak	11.0	171
Red oak	20.6	208
Red oak	13.5	217
Red oak	21.1	209
Red oak	24.1	237
Red oak	19.5	247
Red oak	13.5	125
Red oak	15.7	216
Red oak	17.3	248

Table 10b . Size and age structure of trees cored within the Hemlock old-growth area on Wachusett Mountain.

Species	DBH (cm)	Age
Black birch	44.0	238
Black birch	21.6	151
Black birch	47.2	198
Black birch	26.4	159
Black birch	52.7	212
Hemlock	28.5	189
Hemlock	40.7	146
Hemlock	56.0	192
Hemlock	43.2	217
Hemlock	53.5	211
Hemlock	30.7	163
Hemlock	47.9	207
Hemlock	69.9	255
Hemlock	49.2	176
Hemlock	71.2	180
Hemlock	84.8	219
Hemlock	32.6	180
Hemlock	64.5	173
Hemlock	68.2	158
Hemlock	33.0	174
Hemlock	23.9	195
Hemlock	36.3	205
Hemlock	50.8	210
Hemlock	48.1	196
Hemlock	64.6	157
Hemlock	50.2	245
Hemlock	30.5	159
Hemlock	26.5	162
Hemlock	64.3	165
Hemlock	34.4	115
Hemlock	24.4	137
Hemlock	20.3	166
Hemlock	50.3	170
Hemlock	40.5	183
Hemlock	40.6	177
Hemlock	34.7	210
Hemlock	34.9	180
Hemlock	25.5	185
Hemlock	40.2	175
Hemlock	44.0	200
Hemlock	24.8	160
Hemlock	41.2	183
Hemlock	57.9	179
Hemlock	61.0	187
Hemlock	63.7	243
Hemlock	56.3	197
Hemlock	47.1	201
Hemlock	49.2	238
Hemlock	60.3	147
Red maple	30.1	134
Red maple	21.8	104
Red maple	48.3	123
Red maple	25.9	104
Red oak	47.0	191
Red oak	57.0	204
Red oak	57.9	305
Red oak	28.0	171
Red oak	52.3	208
Red oak	34.2	217
Red oak	53.5	209
Red oak	61.2	237
Red oak	49.5	247
Red oak	34.4	125
Red oak	39.9	216
Red oak	44.0	248

IMPACT OF PROPOSED DEVELOPMENT ON THE FORESTS OF WACHUSETT MOUNTAIN

Final Report September 22, 1997

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In July 1996 the three authors from Harvard Forest submitted a final report on old-growth forests on Wachusett Mountain to the Massachusetts Department of Environmental Management (Foster *et al.* 1996). In summary, the report: (1) supported the comprehensive review of land-use history compiled by Dr. Charlie Cogbill (1996) for the leased ski area that identified strong land-use impacts on the lower slopes and summit of the mountain and documented the existence of protected areas of forest on the mid and upper slopes of the mountain that had been untouched by human activity but were subjected to strong natural stresses and disturbance; (2) confirmed the existence of a large, intact area of old-growth forest outside of the leased ski boundary of 75 to 100' acres (30 - 40 ha); (3) located many trees nearly 200 years of age and over a dozen exceeding that age; and (4) recommended further work to clarify the extent and patchiness of old forest, the disturbance history and overall forest dynamics.

In spring 1997 the Harvard Forest group accompanied personnel (Bill Rivers, Tom Lavoie, Chuck Pernaa, Joe Dombrow) from DEM to Mount Wachusett in order to discuss two proposed development activities: (1) relocation of many of the towers from the open summit area to an adjoining, lower forest area and erection of a communications building, and (2) development of a new trail extension (proposed trail 8A) off of trail 8 (see Map 1 for general location of both activities). Due to the extreme patchiness and variation of the forest and the general difficulty of assessing stand age characteristics on the basis of tree size and shape, it was decided that the Harvard Forest researchers would undertake field studies in order to assess, primarily, the old-growth status of forests in the areas of proposed development. In the following sections results and conclusions from each area are presented separately.

SUMMIT AREA

The focus of our evaluation was the forest area lying between Harrington Trail, the summit road and the open summit (Map 1). Results are presented in terms of two sub-areas: the proposed communications building site (1950 - 1975 ' elev. (594 - 602 m); aspect SW 60°) just west of the existing parking lot, and the surrounding area, including the two small patches of forest east of the electric line (1900 - 1975 ' elev. (579 - 602 m)) and the proposed parking lot expansion. In both areas we undertook a field assessment of stand composition and structure, compiled a list of common species and noted uncommon species, and aged a number of the largest and tallest trees that appeared to be the oldest, based on our prior work on Wachusett and elsewhere.

The forest in the area of the proposed communications building site is characterized as follows:

Overstory trees, with diameters ranging from 6 to 20 " (15 - 50 cm) dbh and generally between 20 to 40 ' (6 - 12 m) tall, consisted primarily of red oak, American beech, red maple, and a few hemlock. The sapling layer was comprised of red oak, red maple, mountain ash, witch hazel, beech, striped maple and serviceberry while the seedling layer contained red oak, beech, and black cherry. Herbaceous cover varied across the area from sparse areas to large patches of Pennsylvania sedge or hay-scented fern. Additional species common in the herb layer included Canada mayflower, bindweed, whorled aster, sarsaparilla, wild oats, starflower, and bluebead lily. Raspberry and blueberry species were the most common shrubs encountered.

In the areas just south of the existing parking lot in the area proposed for expansion the overstory composition remained similar to above with red oak the most common species along with beech, and a few hemlock and shagbark hickory. Sedge here was even more abundant and occurred with sarsaparilla, goldenrods, bluebead lily, honeysuckle, and Canada mayflower. Polypody was commonly observed on rock substrates in the area.

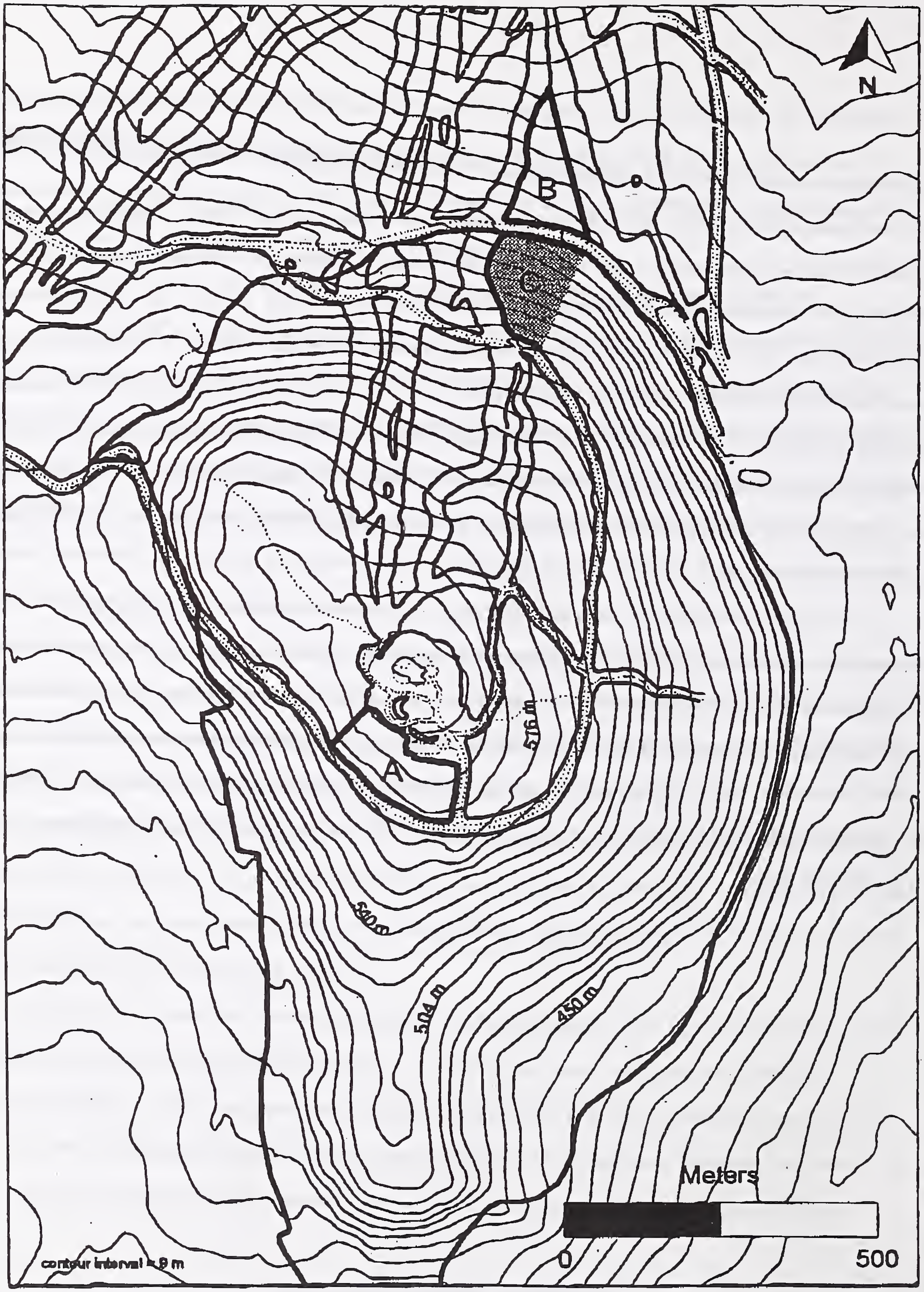
Within the proposed building area seven trees were cored, primarily red oak with one beech and hemlock. Sizes ranged from 6 to 18 " (15 - 46 cm) dbh and ages from 63 to 145 years old. Throughout the remainder of the area an additional thirteen trees were cored including one shagbark hickory. Trees ranged from 7 to 20 " (17 - 51 cm) dbh and ages ranged from 84 to 187 years old (Table 1).

Although this area contains mature trees it is lacking in the very large and very old trees that characterize the old growth forest that covers large parts of the mountain. Presumably the forest has experienced a history of disturbance by human activity (it contained several multiple-stemmed trees, indicative of past cutting and is located 300 - 700 ' (100 - 300 m) from the open summit area, which contained a hotel beginning in the late 19th century) or natural disturbance in the last 200 years, and therefore does not meet the old-growth criteria of Cogbill (1996).

PROPOSED TRAIL 8A EXPANSION

To examine tree age structure and composition in the proposed expansion area, we focussed primarily on trees adjacent to trail 8, between Up Summit Road and Down Summit Road (Map 1; 1400 - 1625 ' elev. (419 - 495 m)). We aged many of the trees in the stand which exhibited old-growth characteristics (Table 2). The forest was comprised primarily of red oak, sugar maple, yellow birch, with a few patches of hemlock and white ash in the overstory, and striped maple and witch hazel in the understory. Sampled trees ranged from 12 to 31 " (30 - 78 cm) dbh and one-third of the trees were older than 200 years, including a dominant red oak that was 285 years old. A dominant feature of this area was the scattered yellow birch in the 20 to 28 " (50 - 70 cm) dbh range. However, many of the birch trees were rotten, and ages had to be estimated from the sound portion of the core that was obtained. Based on examinations of many birch cores on the mountain and in this particular stand, conservative estimates of these trees ranged from 150 to over 300 years old. This upper portion of the proposed expansion contains many mature trees and does not appear to have been cut in the past.

In contrast, the area below Up Summit Road (Map 1; 1225 - 1400 ' elev. (373 - 427 m)) exhibited characteristics of second-growth forests that were intensively disturbed in the past. Common overstory trees included red maple, yellow birch, black cherry, and white pine with a few scattered paper birch. The majority of trees were smooth-barked, multiple-stemmed individuals, indicative of past cutting. In addition, the area was bordered on two sides by stone walls, further evidence of past agricultural land use. This area was documented by Cogbill (1996) as the Parker Pasture, which was still active in the later half of the 19th Century. One of the larger white pines in the area was aged at 94 years.



Map 1. Location of study areas (enclosed by thick border) for summit improvements (A) and the proposed trail 8a expansion (B & C) on Wachusett Mountain. Shaded area indicates documented old growth forest. The large boundary indicates area administratively designated as containing old-growth forest in the 1996 report.

Table 1. Age distribution of trees cored on the summit of Wachusett Mountain, in the area of proposed improvements.

Proposed Building area

Species	DBH (")	DBH (cm)	Age
Beech	7.2	18.4	145
Hemlock	6.0	15.2	141
Red oak	11.2	28.4	94
Red oak	13.3	33.9	63
Red oak	12.3	31.2	123
Red oak	15.4	39.2	133
Red oak	18.1	46.0	91

Area from Harrington Trail east to Summit entrance road (including proposed parking lot and new road)

	DBH (")	DBH (cm)	Age
Beech	9.1	23.2	177
Beech	6.8	17.3	110
Red oak	16.0	40.7	107
Red oak	17.6	44.7	137
Red oak	17.8	45.2	165
Red oak	16.8	42.6	187
Red oak	17.2	43.8	177
Red oak	20.2	51.3	107
Red oak	14.5	36.8	84
Red oak	12.9	32.8	87
Red oak	13.7	34.7	172
Red oak	13.4	34.0	133
Shag. Hick.	8.4	21.3	181

Table 2. Age distribution of trees cored within the proposed Trail 8A expansion on Wachusett Mountain. (* estimated ages = aged piece + conservative age of remaining core segment, assuming double and triple [range] the growth rate of the aged segment and subtracting 1" for bark)

	DBH (")	DBH (cm)	Breast Height Age
Hemlock	24.9	63.2	162
Hemlock	25.6	65.1	123++ (17 cm piece--est. * 157 -174)
Hemlock	20.8	52.8	209
Red oak	30.6	77.6	285
Red oak	24.9	63.3	129
Red oak	19.2	48.8	211
Sugar maple	17.0	43.3	151
Sugar Maple	24.0	60.9	121++ (13.5 cm piece-est. *167 190)
Sugar maple	21.7	55.1	203
White pine	24.8	63.0	94
White ash	18.5	47.1	87
White ash	10.7	27.1	41
Witch Hazel	5.3	13.5	48
Yellow birch	27.2	69.2	72 ++(10 cm piece--est.* 127 - 155)
Yellow birch	20.8	52.9	236
Yellow birch	19.4	49.2	125++ (12 cm piece-- est. * 164-183)
Yellow birch	21.1	53.6	154++ (7.5 cm piece- est.* 276 -336)
Yellow birch	20.7	52.6	205

FINAL REPORT ON OLD-GROWTH FORESTS ON WACHUSETT MOUNTAIN

David R. Foster, David A. Orwig, John O'Keefe

August 28, 1996

REPORT ON OLD-GROWTH FORESTS ON WACHUSETT MOUNTAIN

David R. Foster, David A. Orwig, John O'Keefe

Three forest ecologists from the Harvard Forest were invited by the Massachusetts Department of Environmental Management (DEM) to undertake a review of the old-growth forest area on DEM land on Wachusett Mountain (WM). Three tasks were identified by DEM as involved in this overview: (1) to provide a review of the report prepared by Vanasse Hangen Brustlin (VHB), Inc., concerning the forest area leased from DEM by the Wachusett Mountain Associates; (2) to conduct additional field reconnaissance to assess the extent and general age, structural, and compositional characteristics of other suspected old-growth forest areas on DEM Wachusett lands outside the leased area; and (3) to make recommendations for further, more detailed studies that would provide information on the developmental history and long-term dynamics of the old-growth forest that would be pertinent to the oversight and management objectives of DEM.

In addressing these three issues we base our comments and recommendations below on an introductory field excursion to Mount Wachusett with DEM personnel in November of 1995, approximately two weeks of field studies conducted in the spring and early summer of 1996, interviews and discussion with Drs. Charlie Cogbill and Peter Dunwiddie (forest ecologists who have conducted the initial assessment of the forest for VHB and the Massachusetts Audubon Society, respectively), and our extensive experience as forest ecologists familiar with the vegetation and forest history of New England and the dynamics of old-growth forest across northeastern North America.

Review of Report by Vanasse Hangen Brustlin

The report by VHB consists of two distinct parts: a lengthy review of the forest history and modern forest conditions of the area of WM leased by Wachusett Mountain Associates prepared by

Dr. Charlie Cogbill, forest ecologist and consultant from Plainfield, Vermont and a briefer, cover letter by Dr. Lisa Standley of VHB. The cover letter is editorial in nature and does not contribute additional scientific data to the Cogbill report.

The Cogbill report is remarkably comprehensive in its review of historical documentation pertinent to understanding the range of natural environmental, disturbance, and land-use history factors that may have impacted the Wachusett area historically and shaped its modern characteristics. Diverse sources that were used in this historical research include original surveys, colonial province records, and legal documents related to the laying out of the towns of Westminster and Princeton, surveys of early roads, ownership deeds, contemporary writings from the 18th, 19th and 20th C (e.g., Peter Whitney's and D. H. Hurd's *History of Worcester County*, H. D. Thoreau's *Journals.*, Heywood's *History of Westminster*, F. E. Blake's *History of Princeton*), archival records, diverse cartographic resources from the 19th and 20th C, and interviews with pertinent individuals involved with the history, management and ecology of Massachusetts' forests. The diversity of resources utilized and the scope of this historical overview is consistent with the highest caliber academic research. Considerable effort would be required to improve on the detail of this historical investigation.

Based on historical studies Cogbill makes a number of noteworthy observations including: (1) the longstanding existence of major environmental gradients and corresponding structural and compositional gradients in the forest vegetation across elevation on the mountain; (2) most of the lower slopes of the mountain and adjoining areas were heavily impacted historically for agriculture and wood products; (3) the summit area of the mountain was impacted by tourism and possibly by removal of forest products; (4) the slopes of the mountain were dissected by roads and ski trails; (5) pockets of forest were left untouched through the historical period because they were difficult to access, damaged by natural disturbance or stunted and of low timber value; (6) with the advent of agricultural decline the former open and heavily impacted areas have regrown to forest, creating a nearly continuous matrix of forest surrounding the untouched pockets; and (7) the entire area has been subjected, differentially, to the impacts of slope instability, ice damage, chronic wind exposure and hurricane winds. We find the historical research on which these conclusions are drawn to be quite sound and we support these basic conclusions.

Based on this historical research Dr. Cogbill conducted a limited (4 days) amount of field work and assembled his observations and data with other information collected by Dr. Peter Dunwiddie into an assessment of the characteristics of the forest. Of particular interest was the age of dominant trees and stand history, determined through dendroecolgoical means, and the structure and composition of the forest, determined through field observations and measurements in fixed plots. Cogbill based his criteria of old-growth status on a system that he developed in 1981 including:

1. a minimum size homogenous area capable of continuously supporting a forest stand (5 acres);
2. minimum percentage of the maximum longevity reachable by the dominant tree species;
3. undetectable human influence;
4. evidence indicating the presence of a subsequent tree generation.

In Cogbill's view "the critical determination is an assessment of specific stand historic integrity and continuity." The field methods and old-growth criteria utilized appear entirely reasonable and appropriate to the objectives of this report. As noted later, much more extensive field work is warranted to evaluate comprehensively the nature and dynamics of these forests.

Field studies by Dr. Cogbill led to the following conclusions related to the area leased from DEM by WMA: (1) forests across the elevational gradient were regularly impacted and shaped by wind, snow, rain and ice-caused breakage, hurricanes, slope instability and other uncertain disturbances; (2) vegetation types and characteristics are strongly controlled by slope position as influenced by bedrock geology, slope, soil depth, and exposure to wind and ice damage; (3) five different communities were identified with four distinct types on the north slope (Toe, Ledge, Hemlock and Brow); (4) tree cores of the Toe site indicate a median age of 172 and maximum of 295 years, with red oak and yellow birch approaching their maximum age. Limited age data from the other communities suggest that: the Ledge site has very old trees (median age > > 133 years on yellow birch) with little indication of disturbance, the Brow has oaks exceeding 200 years of age with some suggestions of ancient disturbance and one indication of 20th C selective logging, and the hemlock site has trees exceeding 240 years of age and "could have been used historically for tan bark at the approximate time (~ 1860) of establishment of the youngest cored tree"; (5) the forests appear to exhibit little impact of bisection by the four ski trails, liftline and snowmaking pipelines, although the patches of forest between trails indicate edge effects roughly equal to one tree height. The conclusions reached by Dr. Cogbill appear to fit his observations and data well and are corroborated by our own field observations and data collection.

The historical research and field analysis of the northeast slope of WM lead Dr. Cogbill to the following conclusions concerning the old-growth status of the area:

(1) the forest area above the toe of the slope has been generally undisturbed by human activity or natural disturbance and therefore meets the land-use criterion for old-growth;

(2) trees cored on the "mountain lot" of WM have a grand median of more than 177 years and therefore meets the age criterion for old-growth;

(3) the forest has a diverse size and age structure with ample regeneration and therefore meets the stand replacement criterion for old-growth;

(4) a number of the intact forest areas exceed the minimum (5 acres) proposed by C. Cogbill or alternative minimum area (12 acres) for old-growth proposed by P. Dunwiddie.

On the basis of these conclusions Dr. Cogbill argues that the WM area does support significant stands of old-growth forest. Notably, Cogbill suggests that the significance of these forest stands is increased by the diversity of vegetation types, the dominance of deciduous hardwood species, the presence of an unusual yellow birch talus community, the location of WM in the eastern part of Massachusetts, and the relatively large increase that these areas make in the state total of identified old-growth forest. Our field examinations support these conclusions. In addition, and as noted below, the structural characteristics of the forests and individual tree architectures increase the distinctiveness and value of these forests.

Field Observations, Vegetation Sampling, and Dendroecological Analyses

We have undertaken an initial reconaissance of the area to determine the nature and extent of old growth forest with an emphasis on the area outside the WMA leased area studied by Dr. Cogbill. We obtained tree ages and estimated overstory tree basal area at various locations (Table 1). Our preliminary field results suggest that there is a large, intact area of old-growth forest outside the leased ski boundary. The area includes a wide band of forest corresponding to and extending south from the zones referred to as "Toe 4" and "Ledge 3" in the Cogbill report. This area extends from directly above and north of the visitors' center, south and west around the mountain to well beyond Harrington Trail adjoining "Brow 1 and Ledge 1" in the Cogbill report (Sites 3 - 6, Table 1). The majority of trees sampled within this band were red oak and yellow birch which ranged in age from 160 to 250 years old. In addition, observed tree characteristics were consistent with findings by Cogbill of forests subjected to repeated disturbances and harsh growing conditions. Trees were widely spaced and consisted of gnarled, tapering tree boles with stunted canopies containing tufts of small branches. Several locations, especially southern and southeastern aspects, contained evidence of substantial wind disturbance.

Forests corresponding to the"Brow" zone in Cogbill's report located near the summit outside the leased area, varied considerably in structure and composition. The west side of the summit (Site 1, Table 1) contained a dwarf forest of stunted (16 ' tall) red oaks ranging from 100 to 180 years old, while the east side just south of Pine Hill Trail and above Down Summit Road (Site 2) contained beech, and taller, larger red oaks over 200 years old. A few sites within the leased area were also briefly examined for age structure and site characteristics. Tree ages within the narrow band of red spruce on the upper north slope of the mountain (west of Cogbill zone B2) varied from 80 to 150 years old and a yellow birch on the talus slope (Cogbill zone L1) below was approximately 208 years old. The oldest trees cored were two red oaks in the proximity of Old Indian Trail in the lower brow (Cogbill zone B1) and upper toe sections (Cogbill zone T1) which were 285 and 307 years old, respectively. We very roughly estimate the acreage of old growth forest outside the leased area to be from 75 to 100+ acres. This forest is contiguous with similar forest inside the leased area which further enhances the ecological significance and statewide importance of the site.

Proposed Research

The old-growth forests on Mt. Wachusett represent a rare opportunity to examine forest development, structure, and successional dynamics of sites which have largely been eliminated from the eastern U.S. landscape. These trees contain lengthy records of growth in their annual rings and therefore provide important insight into past events including frequency and intensity of disturbances, stand characteristics, tree recruitment events, and general climatic information. This information is extremely valuable for increasing our understanding of the historical, and current, ecological development of forest stands and will be useful for directing protection and management efforts in these stands. The old-growth hardwood forest stands on Wachusett Mountain present the opportunity for urgently needed additional comprehensive research. This site contains some of the few apparently undisturbed old-growth forests located east of the Connecticut River in Massachusetts and as such the rarity, hardwood nature, and elevational setting of these stands allows an unusual opportunity to investigate the natural dynamics and development of this forest ecosystem. In view of the potential significance of this site we recommend further evaluation of the successional status and long-term forest stand dynamics of the area by examining the age, structure, and composition of the vegetation in conjunction with a dendroecological analysis of growth patterns of young and old trees and analysis of the orientation of downed stems. A suggested protocol for continuing this important research follows.

Vegetation would be sampled in permanent plots established along transects in designated old-growth stands. Plots would be spaced at predetermined intervals through representative portions of designated old-growth forest and plot corners would be permanently marked with iron pipe. In each plot, the species, diameter at breast height (dbh), and canopy position would be recorded for each woody stem larger than a certain diameter (8 cm recommended). A relative importance value would be calculated for each species by summing relative density and relative dominance (basal area) and dividing by two. All saplings (stems > 1.5 m tall and < 8 cm dbh) would be counted by species within each overstory plot and all seedlings (stems/< 1.5 m tall) would be counted by species within 5 - 10 randomly located 1 m^2 nested sub-plots. Shrub and herbaceous cover (%) would also be estimated within each nested sub-plot.

For radial growth analysis and age determinations several trees in each plot, randomly selected and spanning all species and size classes, would be cored with increment borers at 1.37 m height. Cores would be air dried, mounted, sanded, and aged with a dissecting microscope. Ring widths would be measured to the nearest 0.01 mm.

Within representative stands the orientation of downed trees would be ascertained to examine the extent of wind damage and document other unknown disturbance events. Each windblown stem would be identified by species when possible, otherwise as hardwood or conifer, and classified as uprooted, bole snapped, or unknown. The slope, aspect, and topographic position would be characterized at each location.

Table 1. Results of preliminary field studies and dendroecological analysis on Wachusett Mountain. Data are organized by site, keyed to Figure 1 and include information on the species diameter, age, and notes pertaining to individual trees that were cored. The basal area of the forest surrounding selected coring locations was obtained using a 10-factor cruise-all.

Site 1 (dwarf forest)

Core #	Species	DBH	Age	Cruise (ft.^{2} /acre)
1	red oak	28.5	102+	RO 100
2	red oak	43.2	181+	RO 60 beech 50 Rm 10
3	red oak	43.4	173	BC 10 RO 40 beech 80
–	Red oak (rotten)			(Hick 10, BC 10, YB 10, RO 70, Rm 10)

Site 2 (corner above down summit road)

Core #	Species	DBH	Age	Cruise (ft.^{2} /acre)
4	red oak	41.8	205	RO 40 beech 60
5	red oak	43.1	206?	beech 60 RO 50 Rm 10 str.m 20

Site #3 (proceeding southwest from pine hill trail) (May 16, 1996)

7	red oak	48.3	126	RO 50
8	red oak	66.0	199 est. 203	YB 20 Rm 20 Ostrya 20
9	beech	50.8	217	YB 10 beech 80 str.m 10 RO 10
10	Y. birch	41.7	120+	S.hick 10 Sug.m 30 RO 10 YB 40
11	red oak	68.2 broke rotten center	112 (outer 10 cm !)	RO 80 Ostrya 20 W.Haz 10 Rm 40 W.ash 10
12	red oak	53.0	188	RO 90 beech 10
13 not far from Loop trail	red oak	73.3	252+ (no center reached)	RO 40 Rm 20 S.hick 10 Sug. m 20 beech 10 W. haz. 10

Site 4 Down Harrington Trail

14	red oak	52.1	192+	Ro 80 Hem 10

(rotten center) bbirch 10 Rm 40

Site 5. Above visitor center, below Down summit road, along upper to mid-slope talus, heading south to just beyond the Harlow overlook (plus core #7 above Down summit road, on south side of Pine Hill Trail .

Core #	Species	DBH	Age	Cruise (ft.^{2} /acre)
1	red oak	73.9	103 ++ –	
2	red oak	55.3	222	–
3	red oak	60.0	182	–
4	Y. birch	70.1	162	YB 50 Str.m. 30
5	Y. birch	52.9	216	YB 20 RO 30 Rm 10 hem 20
6	Y. birch	37.7	176	YB 50 Str.m 10
7	red oak	46.8	190	RO 40 beech 30 Str.m 10 Rm 10

Site 6. Southwest of Up Summit Road.

Core #	Species	DBH	Age
11	B. Cherry	51.1	95
12	red oak	73.2	195 (estimated 205-210)

Red Spruce Stand (and adjoining talus)

1	R. spruce	36.0	64
2	R. spruce	40.9	150
3	R. spruce	41.8	83
4	R. spruce	36.0	140
5	Y. birch	29.3	208

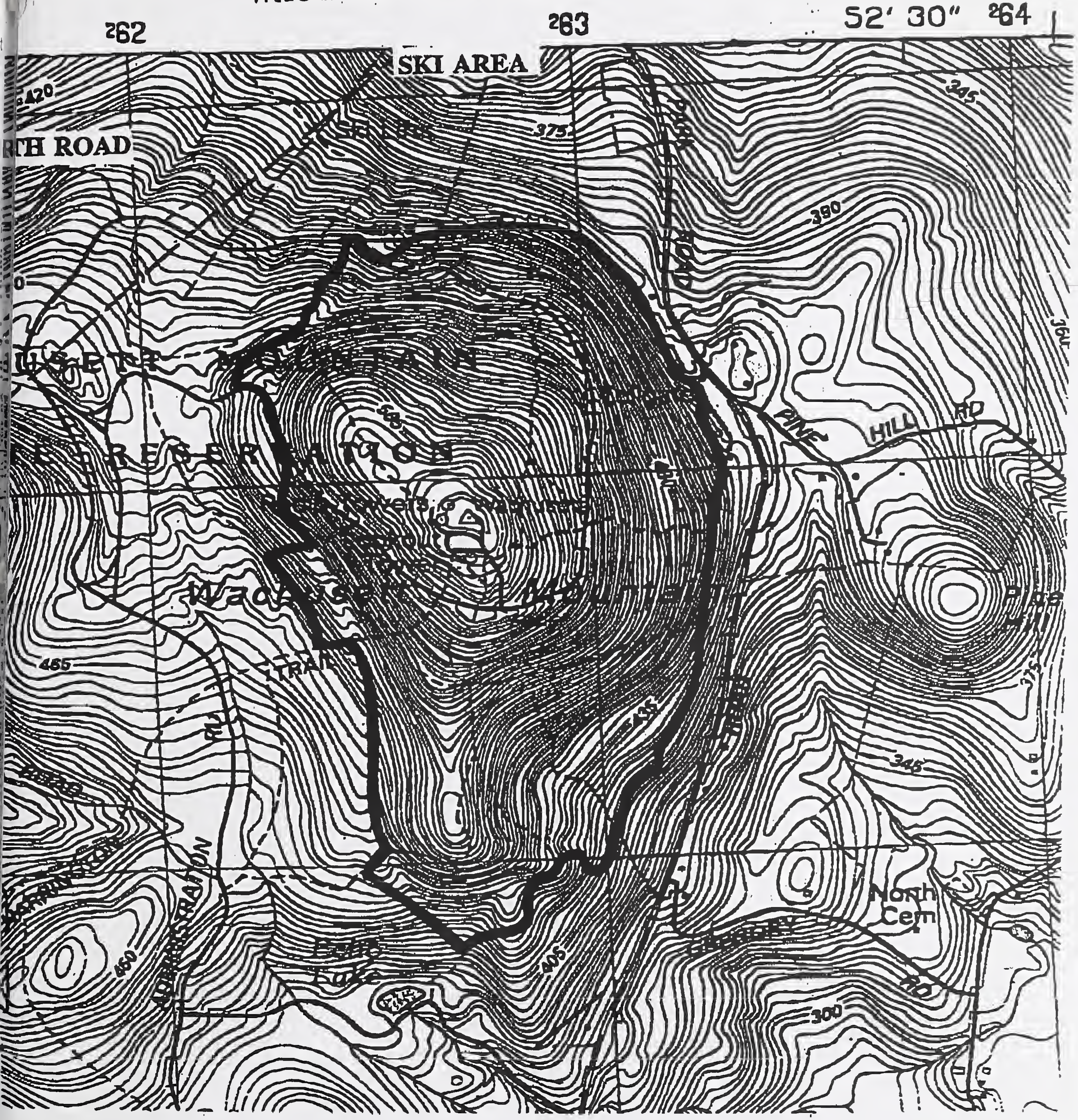
Old Indian Trail (East and West of trail)

8a	red oak	71.4	285
8	Y. birch	44.1	154
9	red oak	55.5	307

Site 7. Northeast of Echo Lake. East of power line.

Core #	Species	DBH	Age
1	red oak	74.3	196
2	sugar maple	77.2	166
3	hemlock	64.5	173
4	hemlock	49.2	238
5	red oak	28.0	171
6	red oak	53.3	219

WACHUSETT MTN OLD GROWTH AREA



APPENDIX D

Lichen Report

Lichens of the Old-Growth Forest Administrative Area
Wachusett Mountain State Reservation

by Philip F. May
August 7, 1998

Report submitted to
Department of Environmental Management
Division of Forests & Parks
Region 3

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Abstract. A survey of the old-growth areas of Wachusett Mountain yielded 150 species in 72 genera. This represents higher diversity than for recently well-studied secondary forests in central and eastern Massachusetts. Sixteen old-growth indicators species from northern New England were found on site, somewhat less than the number needed to demonstrate ecological continuity since pre-colonial times. A likely source of disturbance is Industrial Age air pollution, from which the forest may now be recovering. Nonetheless, several species were found during the study that have been rarely collected in Massachusetts (although are not necessarily actually rare). Despite possible disturbance from air pollution, the site appears to serve as a refugium for lichen species that were once more widely distributed in Massachusetts.

Introduction

The lichens of the old-growth areas on Wachusett Mountain were surveyed under permit from the Department of Environmental Management. A total of 11 person-field days were spent on site either identifying lichens *in situ* or collecting them for identification in the laboratory. The principal investigator was assisted on two days by Elisabeth Lay and on one day by Steve Selva, who searched for lichens in the order Caliciales. Elizabeth Kneiper assisted for a day and took photographs.

Long undisturbed forests are generally known to contain a higher diversity of lichen species than mature secondary forest (Goward, 1994; Rose, 1976; Selva, 1994, 1996). Certain epiphytic species can only maintain themselves by having continuously available the microhabitats--irregularly distributed in time and space--found in very old forests above a minimum size. Certain other epiphytic species find it difficult to disperse and establish themselves in general. Assuming spacially random establishment, the length of time available for colonization makes it more likely that the species will be found on old substrates than younger ones. Thus the longer a forest has existed since last major disturbance (fire, hurricane, logging, pollution), the more diverse the lichen flora is likely to be.

Little is known of the lichen diversity of old hardwood forests in southern New England. The purposes of this study were (1) to see if new lichen species could be added to the flora of Massachusetts, (2) to compare the diversity at Wachusett Mountain with other southern New England localities, and (3) to compare Wachusett Mountain with other well-studied old-growth sites in northern New England.

Sites and Methodology

Standard non-randomized survey methods were used. Nine sites were surveyed representing all the habitat types and study areas mentioned in the final report by Harvard Forest researchers (Foster et al., 1997) and in Cogbill's original report (1996). Study sites are listed in the Appendix 1 and shown on the attached map.

At each site, all available substrates and microhabitats were systematically examined. The substrates searched include bark on the lower trunks of all major tree species and some larger shrub species; exposed wood of snags, stumps, logs, and living trees; rock outcrops and talus; moss; duff; and soil. Recently fallen trees were located, and their upper branches and canopy twigs were examined for lichens. Root cavities and rock recesses were searched for lichen species that specialize in these microhabitats. Sterile crusts--often ignored in surveys--were collected extensively. Common lichens were photographed in the field on color slide film using a 35 mm camera with macrolens.

The collected lichens were identified in the laboratory using standard techniques. These include light microscopy, chemical spot tests, and thin-layer chromotography. The few lichens that could not be identified by these means were sent to specialists. One voucher specimen for each species has been placed in the lichen collection of the Farlow Herbarium at Harvard University.

Results

A total of 150 species in 72 genera were identified. Of these, 99 species were found on bark or wood (epiphytic lichens), 58 species were found on rock, and 9 species were found on soil or duff. The total of these categories exceeds 150 species because some lichens occur on more than one substrate type. An annotated list of lichen species is presented at the end of the report.

Virtually all the lichen diversity lies within the hardwood stands. Almost no lichens are growing in the old-growth hemlock stand just east of the power line, south of the summit. It is a "lichen desert." A few lichens grow on the hemlocks and red spruce located elsewhere in the old growth administrative area, but diversity is low.

Overall coverage of trees is quite variable, with some trees having moderate coverage and other trees very little coverage. Lichen coverage is greatest on the lower trunks of trees, with less coverage on main branches and the upper trunk and little coverage on small branches and twigs, including the canopy. Coverage of exposed rock surfaces by lichens is moderate to high.

Lichen coverage on soil and duff is generally low. Coverage of substrates by lichens was not directly measured, so the preceding statements should be treated as field impressions.

The distribution of epiphytic lichen species among the growth forms and algal types is given in Table I. The data for the Adirondacks comes from a study that used different methodology, but should be roughly comparable.

Table I. Epiphytic lichens: percentage of total species in study, by growth form and algal type

Lichen type	Wachusett Mt.	Adirondack Mts.*
foliose	23 %	30 %
pendant or shrubby fruticose	3 %	3 %
squamulose- or crustose-fruticose	3 %	6 %
crustose or squamulose	71 %	61 %
with cyanobacteria	0.6 %	5 %
with green algae	97 %	95%
algae lacking**	2.6 %	0 %

*data adapted from Schmitt and Slack (1990).

** The species lacking algae are non-lichenized fungi taxonomically similar to lichens and normally included in lichen floras.

Discussion

One's first impression of the old growth forest on Wachusett Mountain is that it is not lichen rich. It lacks both the coverage found in more humid regions, such as the White Mountains of New Hampshire, or coastal Maine, and it seems to lack diversity, as well. Investigation has revealed, however, that despite only having moderate coverage, a surprising amount of diversity is present. The diversity comes from lichen species that are represented at low to very low densities.

Most of the species on the species list fall into this low-density category, including species that are moderately common regionally. These low density species are only found after intensive searching, making the total species count sensitive to the amount of time spent in the field. On the other hand, most of the coverage is provided by a few common species.

This distribution pattern is normal in New England, except that is somewhat exaggerated at Wachusett Mountain. The large number of low density species could indicate that recolonization is taking place following decades of air pollution in the first half of the century. Lichen recolonization is believed to be taking place throughout eastern and central Massachusetts, certainly in the big cities. However, species diversity is much higher at Wachusett Mountain than in secondary growth areas.

Table II compares lichen diversity in the old-growth area on Wachusett Mountain with two secondary forest sites in Massachusetts. The comparison is restricted to epiphytic lichens, as these substrates are common to all the compared study areas. Epiphytic lichens grow on trees, shrubs, snags, and logs, and also on mosses, lichens, and polypores found on trees and shrubs.

Table II. Lichen diversity of three Massachusetts study sites (epiphytic species only)

Locality	Area (acres)	Field days	Comment	Species
Wachusett Mount. old growth area	circa 130	11	old growth hardwoods	99
Westover Air Reserve Base (green areas)*	1500	18	small patches of secondary forest	74
Cape Cod Canal**	1100	20	maritime secondary pitch pine/hardwood	83

*data adapted from Kneiper et al. (1995).
**data adapted from Lay et al. (1995).

The old growth area on Wachusett has considerably more diversity of epiphytic lichens than either Westover Air Reserve Base or Cape Cod Canal, despite being one-tenth the size and being surveyed for less than two-thirds the time. Westover is a site with relatively young, but diverse, forest patches subject to edge effects and a probable history of air pollution. Cape Cod Canal has a somewhat older, primarily oak-pitch pine forest, a more maritime climate, and presumably relatively little historical air pollution. It is likely that the relatively high diversity of the Wachusett Mountain study area is due to it's much older age.

Little lichen work has been done in old-growth stands in southern New England. However, in northern New England, extensive data is available. Table III compares Wachusett Mountain to selected old growth forests in northern New England and New York.

All of the hardwood-dominated stands cited in Table III are considered to be old-growth sites based on standard criteria such as the structure of the forest and known age distribution of the trees. A lichenological index based on indicator species, developed by Selva (1994, 1996) for northern New England, is designed to assess ecological continuity over longer periods than can be assessed by tree-based methods, which are limited to the presently growing trees, plus decaying members of a previous generation. In this concept, old growth forests can be relatively young--a few hundred years--or relatively old ("ancient")--several hundreds of years. Selva has somewhat arbitrarily selected the minimum figure of 20 indicator species present as indicating a forest that has had no major disturbance since ancient times.

TABLE III. Lichen diversity of selected hardwood-dominated old growth forests (epiphytic species only)*

Locality	Area (acres)	Field days	Total epiphytic species	Calici-ales species	old growth indicator species
Big Reed Preserve northern Maine	5000	4	136	21	38
Musquacook, northern Maine	125	4	105	11	31
Yankeetuladi Hardwoods, Maine	240	4	97	10	25
Wachusett Mount. old-growth area	**130**	**11**	**99**	**12**	**16 (20?)****
Mountain Pond Carroll Co. NH	120	4	82	9	20
Gifford Woods Rutland Co. VT	5	4	80	10	18
Lunksoos Mountain northern Maine	10	4	78	5	18
Chandler Ridge E-central Vermont	42	4	53	6	9

*non-Wachusett data from Selva (1994, 1996). The number of indicator species were calculated from Selva's Index of Ecological Continuity and include both hardwoods and conifers.

**includes four species growing on deciduous trees at Wachusett Mountain, but only on conifers in northern New England.

So, for example, Chandler Ridge may meet forestry criteria for old-growth status, but the lack of lichen diversity indicates that it has been subject to major disturbance sometime in the past several hundred years. On the other hand, Big Reed Preserve, Musquacook, and Yankeetuladi all well exceed 20 indicator species. Selva considers them clear examples of truly ancient hardwood forests. Mountain Pond qualifies barely. Gifford Woods and Lunksoos are borderline on the low side.

How does Wachusett Mountain fit in? We must proceed cautiously. First and most important, much more time was spend surveying Wachusett Mountain than the sites in northern New England. The Wachusett species count would have been much lower with only four field days of surveying. Second, at Wachusett four species were found on hardwoods that Selva considers old-growth indicators if found on conifers. Under Selva's system, they are not counted, but if they were, it would bring the count up to twenty indicator species. Third, Selva's indicator species were selected for northern New England, not southern New England.

Allowing for the caveats, especially for the differences in survey time, it is unclear whether the old-growth stand on Wachusett Mountain has been free from disturbance for several hundred years. It seems unlikely. For one thing, Wachusett Mountain lies downwind from known former sources of SiO_2 air pollution: the industrial towns of the Connecticut Valley. Although average annual SiO_2 levels have been low since 1982 (in Fitchburg, the locality with the nearest monitoring stations), there is every reason to suspect that the lichens on Wachusett Mountain were exposed to damaging levels of SiO_2 from the late nineteenth to the mid-twentieth century. Since many species of lichens are highly sensitive to SiO_2 levels and other airborne pollutants, one might expect impact in terms of both coverage and diversity at the study site. Such negative impact has been documented for urban and rural areas of Europe and the United States and also for suburban area in eastern Massachusetts. In fact, epiphytic fruticose and cyanolichens--which are particularly sensitive to air pollution--are virtually lacking in the study area.

Other types of natural disturbance in pre-colonial times, such as hurricane-induced blowdown or catastrophic fire, can not be ruled out at Wachusett Mountain by the amount of lichen diversity.

Rarely collected species

Determining rarity for lichens is more difficult than determining rarity for, say, temperate plants. Most plants are big enough to be easily visible, and in temperate regions, they mostly occur in concentrated populations. It is therefore relatively easy to know how many are around.

Many lichens, however, are minute in size, are well camouflaged, or both. These species are not easily observed in the field. Often they are found entirely by accident in the lab while examining more obvious lichens under the dissecting scope.

Many other somewhat larger species occur widely, but at low densities. They are observable in the field, but infrequently encountered due to their low density. (This is analogous to trees species in lowland tropical moist forest. One must survey large areas of suitable habitat to learn the true numbers of individuals.) In sum, infrequent observation of a lichen does not imply that few individuals exist or that the species is in any way at risk.

As a result, "rarity" in lichenology is, at this time, usually reserved for species with large individuals whose specimens cannot be missed and whose populations are therefore known to be small. There are none of these rare species at Wachusett Mountain. Some of the less obvious lichens may turn out to be rare, but our knowledge of lichen floristics is simply not sufficient to say so.

That having been said, we found several species on Wachusett Mountain that have rarely been collected in Massachusetts. These include *Agonimia sp., Arthonia helvola, Arthothelium ruanum, Chaenotheca xyloxena, Chaenotheca stenomea, Chaenothecopsis viridireagens, Eopyrenula intermedia, Lecanora aff. hypopta, Lecidea virginiensis, Leparia cf. nivalis, Lithothelium hyalospora, Microcalicium ahlneri, Ochrolechia yasudae, Pertusaria cf. subpertusa, Rhizocarpon aff. anperum (possibly new to science), Rhizocarapon subgeminatum,* *Rimularia badioatra, Rinodina adirondackii, Rinodina ascociscana,Rinodina excrescens, Sphinctrina turbinata*, and some unidentified sorediate crusts. Some of these are also regionally rare.

Conclusion

The presence of so many unusual species in a small area and the relatively large overall diversity, suggest that--despite the possible effects of past air pollution--the old-growth area of Wachusett is serving as a refugium for lichens. These lichen species were presumably more extensively distributed in Massachusetts before most of its forests were cut down.

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Annotated Species List
Lichens

Old-growth Forest Administrative Area
Wachusett Mountain State Reservation
July, 1997, to July, 1998

A voucher specimen of each species listed has been placed in the lichen collection at the Farlow Herbarium, Harvard University. Site data is omitted from the list as this information will generally not assist in relocating additional specimens. A few sterile sorediate taxa are omitted from the list as they are still under study by European experts.

Agonimia sp. -- found once on beech, rarely collected in southern New England
Allocetraria oakesiana (Tuck.) Radlane & Thell -- common on the bark of hardwoods, infrequent on rock and on red spruce
Amandinea punctata, *sensu lato* -- occasional on bark of hardwoods
Anaptychia palmulata (Micheaux) Vainio -- infrequent on bark of hardwoods
Anisomeridium biforme (Borrer) R.C. Harris -- found once on red oak
Anisomeridium nyssaegenum (Ellis & Everh.) R.C. Harris -- found once on bark of a stump
Arthonia helvola (Nyl.) Nyl. -- found twice on hardwoods; rarely collected in North America, and not presently on the North American checklist
Arthothelium ruanum (Massal.) Kõrber -- collected once on red oak
Aspicilia caesiocinerea (Malbr.) Arnold -- common on silicic rock
Aspicilia cinerea (L.) Kõrber -- found once on silicic rock, but probably at least occasional
Aspicilia laevata (Ach.) Arnold -- one specimen on silicic rock [determined by Richard Harris;: the boundary between this and the following species (both containing stictic acid) is poorly delimited, with many intermediates. Considered together, they are common.]
Aspicilia verrucigera Hue -- two specimens on silicic rock [determined by Richard Harris; see note under *A. laevata*]
Biatora sp. 1. -- common on hardwoods,. moss on trees, and moss over rock [This common eastern North America species cannot be named at present.. Depending on the authority consulted, it would have been called either" B. helvola" or "B. vernalis" until recently, but apparently neither is correct.]
Biatora sp. 2 (specimen 4229) -- found once on moss on red oak
Bryoria furcellata (Fr.) Brodo and D. Hawksw. -- found once on silicic rock
Buellia dialyta (Nyl.) Tuck. -- common to abundant on bark of hardwoods
Caloplaca sideritis (Tuck.) Zahlbr. -- found once on silicic rock
Candelaria concolor (Dickson) B. Stein -- occasional on bark of hardwoods
Candelariella efflorescens R.C. Harris & Buck . -- occasional on bark of hardwoods
Cetrelia chicitae (Culb.) Culb & C. Culb. -- found once on granitic rock
Cetrelia olivetorum (Nyl.) Culb. & C. Culb. -- found once each on sugar maple and granitic rock
Chaenotheca chrysocephala (Ach.) Th. Fr. -- occasional on bark of yellow birch
Chaenotheca ferruginea (Turner & Borrer) Mig. -- infrequent on bark of yellow birch
Chaenotheca furfuracea (L.) Tibell -- infrequent on yellow birch and rotten wood
Chaenotheca stenomea (Ach.) Müll. Arg. -- found once on yellow birch
Chaenotheca trichiales (Ach.) Th. Fr. -- occasional on firm wood (snags, red oak, yellow birch, red spruce)
Chaenotheca xyloxena Nádv. -- found once on yellow birch
Chaenothecopsis pusiola (Ach.) Vainio -- occasional on firm wood (snags, spruce, red oak, and yellow birch)
Chaenothecopsis savonica (Rãs.) Tibell -- found once on wood
Chaenothecopsis viridireagens (Nádv.) A.F.W. Schmidt -- found once on yellow birch
Chaenothecopsis sp. (spores simple) -- found once on witch hazel and twice on firm wood
Cladina rangiferina (L.) Nyl. -- occasional mats on duff over rock in forest openings

Cladonia bacillaris (Nyl.) -- occasional on rotting wood, duff, and the base of trees; probably common as sterile squamules
Cladonia coniocraea (Flõrke) Sprengel -- occasional on duff
Cladonia cylindrica (A. Evans) A. Evans -- found once on the base of a dead spruce, but probably occasional
Cladonia didyma (Fée) Vainio (poor) -- found once on duff
Cladonia furcata (Huds.) Schrader -- occasional on duff
Cladonia grayi Sandst. -- infrequent to occasional on duff
Cladonia ochrochlora Flõrke -- occasional on logs, moss, duff over rock, and the base of trees; probably common as sterile squamules
Cladonia squamosa (Scop.) Hoffm. -- common on decayed moss over silicic rock
Cladonia unciales (L.) Wigg. -- occasional mats on duff over rock in forest openings
Dimerella pineti (Ach.) Vezda -- found once on yellow birch
Diploschistes scruposus (Schreber) Norman -- occasional on silicic rock
Eopyrenula intermedia Coppins -- found once on yellow birch
Evernia mesomorpha Nyl. -- found once on *Parmelia sulcata* over rock and once on a yellow birch sapling
Flavoparmelia baltimorensis (Gyelnik & Fóriss) Hale locally common on silicic rock
Flavoparmelia caperata (l.) Hale -- common on bark of hardwoods, red spruce, and large shrubs
Fuscidea arboricola Coppins & Tonsberg -- occasional on bark of hardwoods
Graphis scripta (L.) Ach. -- abundant on bark of hardwoods and large shrubs
Hypocenomyce scalaris (Ach. *ex* Liljeblad) M. Choisy -- found once on hemlock and once on silicic rock
Hypogymnia physodes (l.) Nyl.-- occasional, found once or twice each on yellow birch, hemlock, red spruce, mountain ash, and a log
Imshaugia aleurites (Ach.) S. F. Meyer -- found once on a log
Jullela fallociosa (Arnold) R.C. Harris -- common on bark of hardwoods
Lasalia papulosa (Ach.) Llano -- irregularly distributed but locally abundant on silicic boulders; infrequent on the bark of hardwoods
Lecanora chlarotera (Nyl.) -- found once on red oak
Lecanora glabrata (Ach.) Malme -- found twice on shagbark hickory
Lecanora hybocarpa (Tuck.) Brodo -- found twice, on red oak and yellow maple
Lecanora polytropa (Hoffmann) Rabenhorst -- found once on silicic rock
Lecanora symmicta *auct.* N. America -- common on wood and bark of hardwoods [apparently a different species from *L. symmicta* (Ach.) Ach.].
Lecanora thysanophora R.C. Harris in ed.-- common on bark of hardwoods
Lecanora sp. aff. *L. hypopta* -- found once on bark [according to R.C. Harris, this taxon is undescribed]
Lecidea virginiensis Calk. & Nyl. -- found once on granitic rock in a seep, rarely collected in Massachusetts
Lepraria elobata Tonsberg -- found twice, on silicic rock shaded from rain
Lepraria incana (L.) Ach. -- occasional, on silicic rock sheltered from rain
Lepraria lobificans Nyl. -- occasional on hardwoods and moss
Lepraria neglecta (Nyl.) Lettau -- abundant on exposed silicic rock and bark of hardwoods and conifers
Lepraria cf. nivalis -- occasional on silicic rock sheltered from rain
Lepraria sp.#1, (atranorin, rangiformic acid, ± zeorin), occasional, on silicic rock sheltered from rain and on bark of hemlock [a common species in eastern N. Am., but lacking a name]
Lepraria sp #2 (specimen 4260: atranorin and roccellic acid) found once on red oak
Leptogiuim cyanescens (Rabenh.) Kőrber -- found twice on the base of hardwoods (red oak, shagbark hickory)
Lichenothelia sp. -- found once on silicic rock [a lichen-like non-lichenized fungal species)
Lithothelium hyalospora (Nyl.) Aptroot -- found twice on shagbark hickory
Loxospora pustulata (Brodo & Culb.) R.C. Harris -- occasional on yellow birch and sugar maple
Melanelia fuliginosa (Duby) Essl. -- found once on red oak
Melanelia olivacea (l.) Essl. -- found once on yellow birch
Melanelia sorediata (Ach.) Goward & Ahti -- occasional on silicic on rock
Melanelia subaurifera (Nyl.) Essl. -- occasional to common on bark of hardwoods
Micarea erratica (Kőrber) Hertel, Rambold & Pietschmann -- found once on_silicic rock
Micarea melaena (Nyl.) Hedl. -- found twice, on yellow birch and a rotten log

Micarea peliocarpa (Anzi) Coppins & R. Sant. -- occasional to common, on decaying wood, silicic rock, and yellow birch
Microcalicium ahlneri Tibell-- found once on wood, rarely collected in southern New England
Mycocalicium subtile (Pers.) Szat. -- occasional to common on exposed wood of deciduous trees and snags
Myelochroa aurulenta (Tuck.) Elix & Hale -- found twice, once each on red oak and red maple
Ochrolechia androgyna (Hoffm.) Arnold -- found once on red oak
Ochrolechia arborea (Kreyer) Almb. -- common on bark of hardwoods and witch hazel
Ochrolechia trochophora (Vainio) Oshio -- occasional on red oak and shagbark hickory
Ochrolechia yasudae Vainio -- found twice, on silicic rock and red oak
Parmelia omphalodes (L.) Ach.-- found once on granitic rock
Parmelia saxatilis (l.) Ach. -- found once on granitic rock
Parmelia squarrosa Hale -- common on the bark of hardwoods, also on rock
Parmelia sulcata Taylor -- abundant on bark of hardwoods and on silicic rock, occasional on conifers and wood
Pertusaria amara (Ach.) Nyl. -- common on bark of hardwoods, occasional on rock
Pertusaria globularis (Ach.) Tuck. -- infrequent, on bark of red oak or on moss on red oak
Pertusaria macounii (Lamb) Dibben -- occasional on bark of red oak and shagbark hickory
Pertusaria multipunctoides Dibben -- infrequent on bark of yellow birch and sugar maple and on silicic rock
Pertusaria opthalmiza (Nyl.) Nyl. -- found twice on yellow birch
Pertusaria rubefacta Erichsen -- occasional on bark of red oak and shagbark hickory
Pertusaria cf. subpertusa Brodo -- found once on yellow birch
Pertusaria trachythallina Erichsen -- found once on yellow birch
Pertusaria velata (Turner) Nyl. -- occasional on red oak and sugar maple
Phaeocalicium polyporaeum (Nyl.) Tibell -- occasional on the shelf fungus *Trichaptum biformis*
Phaeophyscia rubropulchra (Degel.) Essl. -- abundant on bark of hardwoods
Phlyctis sp. affinity *P. argena* -- found once on silicic rock [this taxon is always found sterile; it may or may not be a separate species from P. argena]
Physcia millegrana Degel. -- abundant on bark of hardwoods and on shrubs
Physcia phaea (Tuck.) Thomson -- found once on granitic rock
Physcia stellaris (L.) Nyl. -- common on bark of hardwoods, found once on rock
Physcia subtilis Degel. occasional on silicic rock and on moss over silicic rock
Physconia detersa ((Nyl.) Poelt -- found twice, on a snag and on shagbark hickory
Placynthiella icmalea (Ach.) Coppins & James -- found once on rotten wood
Porpidia albocaerulescens (Wulfen) Hertel & Knoph -- abundant on silicic rock
Porpidia crustulata (Ach.) Hertel & Knoph -- found twice on silicic rock
Porpidia herteliana Gowan -- found once on silicic rock
Porpidia macrocarpa (DC.) Hertel & A. Schwab. -- occasional on silicic rock
Psilolechia lucida (Ach.) M. Schoisy -- occasional on silicic rock sheltered from rain
Punctelia rudecta (Ach.) Krog -- abundant on bark of hardwoods, shrubs, and confers and on silicic rock
Punctelia subrudecta (Nyl.) Krog -- found twice, on mountain ash and yellow birch
Pyrenula pseudobufonia (Rehm) R.C. Harris -- found once on beech
Pyrrospora varians (Ach.) R.C. Harris -- found once on yellow birch twig
Pyxine sorediata (Ach.) Mont. -- found once on red oak
Ramalina intermedia (Nyl.) Nyl. -- occasional on silicic rock and snags
Rhizocarpon cinerovirens (Müll. Arg.) Vainio -- found once on granitic rock
Rhizocarpon grande (Flotow) Arnold -- found twice on granitic rock
Rhizocarpon hochstetteri (Körber) Vainio -- occasional on granitic rock (seeps and rain channels)
Rhizocarpon rubescens Th.Fr. -- infrequent on granitic rock
Rhizocarpon subgeminatum Eitner -- found once on granitic rock
Rhizocarpon aff. anaperum found once on granitic rock [This taxon conceivably be a new species.; specimen with Alan Fryday in Scotland further study.]
Rimularia badioatra (Kremp.) Hertel & Rambold -- found once on granitic rock, infrequently collected in New England
Rinodina adirondackii Magnussen -- infrequent on red oak
Rinodina archaea aggregate -- found once on red oak

Rinodina ascociscana Tuck. -- found once on red oak, infrequently collected in Massachusetts
Rinodina excrescens Vainio -- found twice on yellow birch, infrequently collected in New England
Rinodina maculans Müll. Arg. -- found once on sugar maple
Rinodina subminuta H. Magn. -- found once on maple
Ropalospora chlorantha (Tuck.) S. Ekman -- occasional on bark of hardwoods
Ropalospora viridis (Tonsberg) Tonsberg -- occasional on bark of hardwoods and once on red spruce
Sarcogyne clavus (DC.) Kremp. -- found once on granitic rock
Scoliciosporum chlorococcum (Stenh.) Vezda -- found occasionally on conifers, hardwoods, and shrubs, but probably common
Scoliciosporum umbrinum (Ach.) Arnold -- found once on silicic rock
Sphinctrina turbinata (Pers. : Fr.) De Not. -- found once on the lichen *Pertusaria macounii* on shagbark hickory
Stereocaulon glaucescens Tuck. -- occasional on granitic rock
Trapelia involuta (Taylor) Hertel -- occasional on silicic rock
Trapelia placaroides Coppins & James -- found once on silicic rock
Trapeliopsis flexuosa (Fr.) Coppins & James -- found once on the base of a fresh hemlock stump
Trapeliopsis viridescens (Schrader) Coppins & James -- found once on a rotten stump
Tripethelium virens Michner -- found twice on (and restricted to) beech
Umbilicaria mammulata (Ach.) Tuck. -- locally abundant on granitic rock
Usnea strigosa (Ach.) A. Eaton -- found once on a root
Xanthoparmelia angustiphylla (Gyalnik) Hale -- found once on granitic rock
Xanthoparmelia conspersa (Ach.) Hale -- abundant on sunny silicic rocks, found once on a root
Xanthoparmelia plittii (Gyalnik) Hale -- found twice on sunny silicic rock, probably occasional
Xanthoparmelia somloensis (Gyalnik) Hale -- found twice on silicic rock, probably occasional
Xanthoparmelia tasmanica (J.D. Hook & Taylor) Hale -- found twice on sunny silicic rock, probably occasional

Addendum, October 1998 (not included in report statistics):

Acarospora fuscata (Nyl.) Arnold -- occasional on silicic rock (inadvertently left off original list)
Vulpicida pinastri (Scop.) J.-E. Mattsson & M. J. Lai -- found once on silicic rock

List of Study Sites
Old-growth Forest Administrative Area
Wachusetts Mountain State Reservation

(see attached map)

Site 1 (E end of Cogbill T1), ca. 75 m to 150 m W of Ski Trail #5, 42°29.6'N 71°53.3'W, elevation 475 to 500 m, old growth oak/northern hardwood forest on 30° N-facing slope.

Site 1A (W end of Cogbill T1), ca. 150-200 m W of Ski Trail #5, above ledge, 42°29.6'N 71°53.4'W, elevation 475 to 500 m, old growth oak/northern-hardwood forest on steep (up to 45°) N-facing slope.

Site 2 (Cogbill B1), ca. 275 m NNW of summit, just W of Old Indian Trail, 42°29.4'N 71°53.4'W, elevation ca. 580 m, semi-open, low-canopy, mixed hardwood forest, on gently sloping terrain with scattered ledges.

Site 2A (just W of Cogbill B1), steep slope above Up Summit Road, ca. 300 m NW of summit, 42°29.3'N 71°53.4'W, elevation ca. 560 to 580 m, semi-open, low canopy, mixed hardwood forest.

Site 3, (about halfway between Cogbill B1 and T1), above second ledge, 75 m E of Old Indian Trail, ca. 500 m N of summit, 42°29.5'N 71°53.4'W, elevation 550 to 560 m, red spruce grove on steep N-facing slope.

Site 4 (Cogbill L3 and T4), slope between entrance gate and Down Summit Road, 42°29.5'N 71°53.0'W, elevation 425 to 480 m, NE-facing talus slope with scattered old yellow birches.

Site 4 (Cogbill L3 and T4), slope between entrance gate and Down Summit Road, 42°29.5'N 71°53.0'W, elevation 425 to 480 m, NE-facing talus slope with scattered old yellow birches.

Site 4A (N end of Cogbill L3), above entrance pullout parking area, 42°29.5'N 71°53.0'W, elevation ca. 450 m, small grove of large hemlocks on NE-facing talus slope.

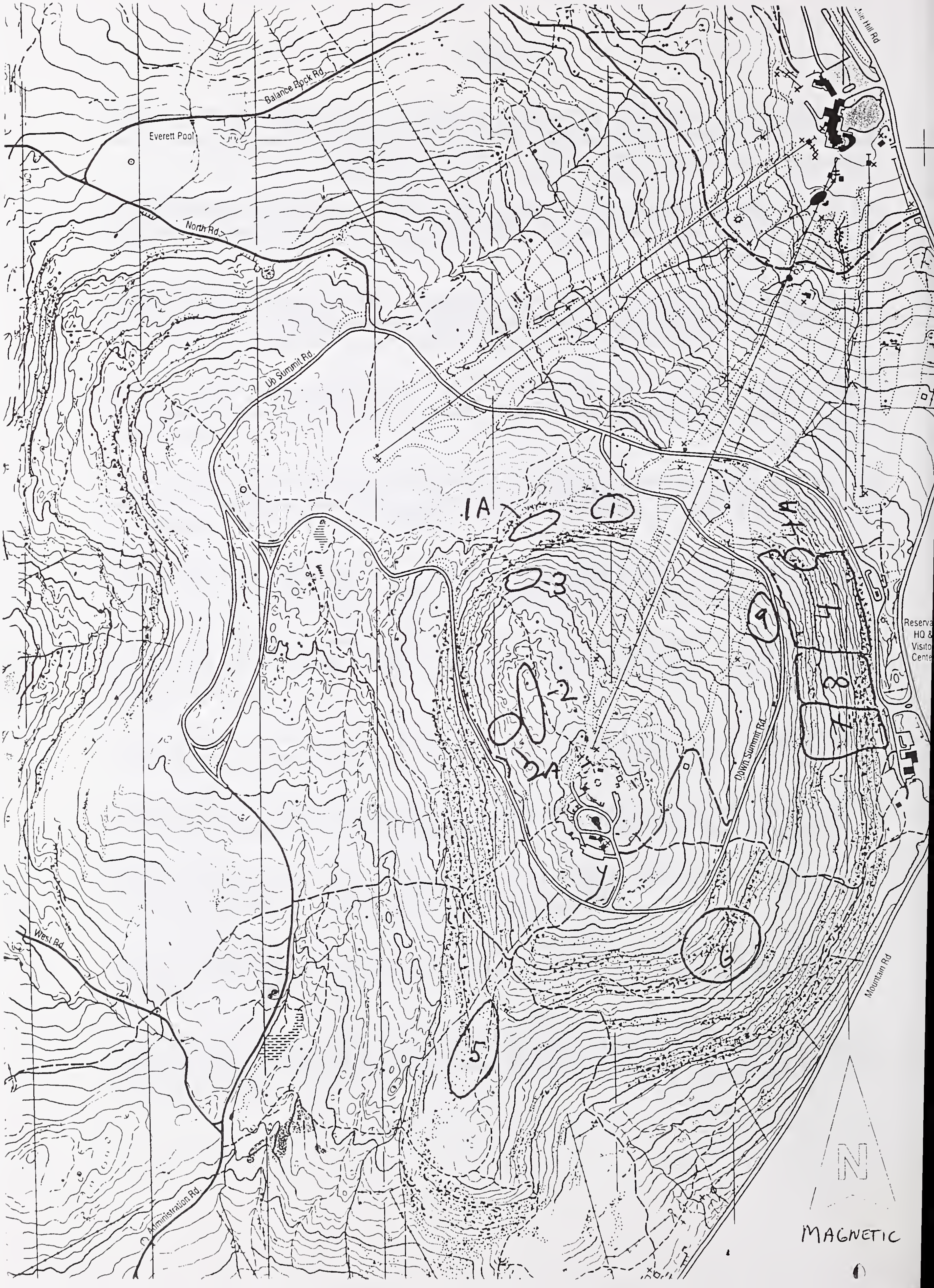
Site 5 ("Hemlock"), 500-750 m S of summit, between upper Jack Frost and Power Line Trails, 42°29.0'N 71°53.2'W, elevation 475 to 525 m, old growth hemlock stand with scattered mixed hardwoods.

Site 6 ("South Talus"), ca 400 m SE of summit, between Down Summit Rd. and Loop Tr., 42°29.2'N 71°53.0, elevation 500 to 550 m, steep SE-facing talus slope with open red oak-yellow birch primary forest.

Site 7 ("East Talus"), 400-600 m ENE of summit, between Visitor's Center and Down Summit Road, 42°29.3'N 71°53.0'W, elevation 425 to 525 m, steep E-facing talus slope with open red oak-yellow birch primary forest.

Site 8 ("East Talus"), 400-600 m ENE of summit, between entrance road and Down Summit Road, 42°29.3'N 71°53.0'W, elevation 425 to 525 m, steep E-facing talus slope with open red oak-yellow birch primary forest.

Site 9 (Cogbill H3), 500 m NNE of summit, between ski trail 8a and Down Summit Road, 42°29.5'N 71°53.1'W, elevation ca. 515 m., hemlock stand on N-facing slope


ile Hill Rd
Balance Rock Rd
Everett Pool
North Rd
Up Summit Rd
1A
1
3
2
2A
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4
9
8
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6
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Reserva
HQ &
Visito
Cente
Down Summit Rd
Mountain Rd
West Rd
Administration Rd
N
MAGNETIC

APPENDIX E

Annotated Species List of Flora of WMSR

Vascular Flora of Wachusett Mountain

- denotes non-native species

NB: Scientific names are those given in Gleason and Cronquist (1991). Asterisks denote species that are believed to be non-native at this site. Records of state-listed species have been excluded from this list. Comments include information on abundance and habitat. Species not seen by Bertin are attributed to other observers; unattributed species were observed by Bertin. Apparent misidentifications are noted.

Scientific Name	*Common Name*	*Comments*
1. Ferns and Allies		
Adiantaceae		
Adiantum pedatum	northern maidenhair fern	uncommon in rich woods
Aspleniaceae		
Asplenium platyneuron	ebony spleenwort	reported by Choiniere
Athyrium filix-femina	lady fern	fairly common in moist woods
Athyrium thelypterioides	silvery glade fern	reported by Choiniere
Cystopteris fragilis	brittle bladder-fern	fairly common on rock outcrops in woods
Dryopteris carthusiana	toothed wood-fern	uncommon in moist thicket near summit
Dryopteris clintoniana	Clinton's wood fern	reported by Wallace et al. 1979
Dryopteris cristata	crested wood-fern	fairly common in swamps
Dryopteris intermedia	fancy wood-fern	fairly common in woods
Dryopteris marginalis	marginal wood-fern	common in rocky woods
Gymnocarpium dryopteris	oak fern	locally fairly common in mesic woods
Polystichum acrostichoides	Christmas fern	common in moist woods
Thelypteris palustris	marsh fern	common along pond margins
Thelypteris phegopteris	narrow beech-fern	fairly common in moist woods
Dennstaedtiaceae		
Dennstaedtia punctilobula	hay-scented fern	common in woods and thickets
Pteridium aquilinum	bracken fern	fairly common in thickets and dry woods
Equisetaceae		
Equisetum arvense	common horsetail	locally common in open ground on summit
Equisetum pratense	meadow horsetail	reported by Wallace et al. 1979 but presumably misidentified as Seymour (1969) does not record the species for the county
Lycopodiaceae		
Lycopodium annotinum	stiff clubmoss	fairly common in mesic woods and clearings
Lycopodium clavatum	running pine	fairly common in mesic woods and clearings
Lycopodium digitatum	southern ground cedar	uncommon in woods
Lycopodium lucidulum	shining clubmoss	fairly common in woods, especially mesic
Lycopodium obscurum	princess-pine	common in woods
Onocleaceae		
Matteuccia struthiopteris	ostrich fern	reported by Wallace et al. 1979
Onoclea sensibilis	sensitive fern	common in wet woods and swamps
Ophioglossaceae		
Ophioglossum pusillum	adder's tongue	formerly present, apparently extirpated
Osmundaceae		

Osmunda cinnamomea	cinnamon fern	common in wet woods
Osmunda claytoniana	interrupted fern	common in moist woods and thickets
Osmunda regalis	royal fern	abundant in swamps

Polypodiaceae

Polypodium virginianum	common polypody	abundant on outcrops and boulders

Selaginellaceae

Selaginella apoda	creeping selaginella	reported by Wallace et al. 1979

2. Gymnosperms

Cupressaceae

Juniperus communis	dwarf juniper	common in dry woods
Juniperus virginiana	red cedar	reported by Wallace et al. , 1979
Thuja occidentalis	northern white cedar	reported by Wallace et al. , 1979

Pinaceae

Abies balsamea*	balsam fir	reported by Vanasse et al. 1998
Larix decidua*	European larch	reported by Wallace et al. 1979 and Choiniere
Picea abies*	Norway spruce	planted near Machis Pool, and occasional seedlings occur in woods
Picea glauca*	white spruce	planted near Machis Pool
Picea mariana	black spruce	reported by Wallace et al. 1979
Picea rubens	red spruce	common in woods at higher elevations
Pinus resinosa*	red pine	common in woods near Echo Lake, presumably planted
Pinus rigida	pitch pine	uncommon on shallow soils over bedrock
Pinus strobus	white pine	common in woods
Tsuga canadensis	eastern hemlock	abundant in woods, moist to mesic sites

Taxaceae

Taxus canadensis	American yew	reported by Wallace et al. 1979 and by Choiniere from woods on southwest slopes

3. Dicotyledons

Aceraceae

Acer pensylvanicum	striped maple	abundant in woods
Acer rubrum	red maple	common in woods, ranging from dry to wet
Acer saccharum	sugar maple	common in woods, particularly on mesic sites
Acer spicatum	mountain maple	abundant in woods, especially on boulder slopes

Anacardiaceae

Rhus copallinum	shining sumac	reported by Choiniere as uncommon along margins of dry pastures near Westminster Road
Rhus glabra	smooth sumac	reported by Wallace et al. 1979
Rhus typhina	staghorn sumac	fairly common in thickets
Toxicodendron radicans	poison ivy	fairly common in woods and along woodland borders

Apiaceae

Aegopodium podagraria*	goutweed	one patch along road near summit
Cicuta maculata	common water hemlock	common on moist, open ski slopes
Daucus carota*	wild carrot	common along woodland borders
Hydrocotyle americana	water pennywort	fairly common in moist ground
Osmorhiza claytonii	sweet cicely	common in rich, rocky woods
Pastinaca sativa*	wild parsnip	one individual seen in disturbed open ground
Sanicula marilandica	black snakeroot	reported by Wallace et al. 1979
Zizia aurea	golden alexanders	fairly common along roadsides and woodland edges

Apocynaceae

Apocynum androsaemifolium	spreading dogbane	common in thickets on summit
Vinca minor*	periwinkle	locally common near former dwellings

Aquifoliaceae

Ilex verticillata	winterberry holly	common in swamps
Nemopanthus mucronatus	common mountain holly	fairly common in thickets and open woods on higher ground

Araliaceae

Aralia hispida	bristly sarsaparilla	common in barren ground near ski area parking lot
Aralia nudicaulis	wild sarsaparilla	common in woods
Aralia racemosa	spikenard	uncommon in mesic woods
Panax trifolium	dwarf ginseng	fairly common in moist woods

Asclepiadaceae

Asclepias exaltata	poke milkweed	reported by Choiniere as quitefrequent along Harrington and Dickens Trails
Asclepias syriaca	common milkweed	uncommon in summit thickets
Vincetoxicum nigrum*	black swallowwort	uncommon along roadside

Asteraceae

Achillea millefolium	yarrow	common in clearings, fields and thickets
Ambrosia artemisiifolia	common ragweed	common in disturbed open ground and along roadsides
Anaphalis margaritacea	pearly everlasting	uncommon along roadsides
Antennaria neglecta	smaller pussytoes	fairly common in open ground, especially in dry soils
Antennaria plantaginifolia	plantain pussytoes	reported by Wallace et al. 1979
Arctium minus*	common burdock	one individual seen along woodland edge on summit
Artemisia vulgaris*	common mugwort	uncommon in thickets and along roadsides
Aster acuminatus	whorled aster	common in woods
Aster cordifolius	heart-leaved aster	common in dry thickets on summit
Aster lateriflorus	calico aster	uncommon in summit thickets
Aster linariifolius	stiff aster	reported by Choiniere from drier fields and ski slopes
Aster macrophyllus	big-leaved aster	fairly common in woods and thickets
Aster novi-belgii	New York aster	fairly common in ditch near visitor center
Aster umbellatus	flat-topped aster	fairly common in thickets and along woodland edges
Aster undulatus	wavy-leaved aster	fairly common in summit thickets
Bidens frondosa	beggar ticks	common in damp open
Centaurea cyanus*	bachelor's button	uncommon on open ski slopes, presumably persisting from a broadcast seed mix

Chrysanthemum leucanthemum*	oxeye daisy	common along roadsides and in clearings
Cichorium intybus*	chicory	uncommon along open paths and roadsides
Cirsium vulgare*	bull thistle	one individual seen in disturbed open ground
Conyza canadensis	horseweed	uncommon in disturbed open ground at summit
Cosmos bipinnatus*		uncommon along roadsides, presumably persisting from intentionally scattered seeds
Crepis tectorum*	hawksbeard	on open ski slopes
Erechtites hieracifolia	pilewort	common along roadsides
Erigeron pulchellus	robin's plantain	locally common in clearings
Erigeron strigosus	lesser daisy fleabane	uncommon in disturbed open ground
Eupatorium dubium	eastern joe-pye weed	fairly common in moist thickets and along shores
Eupatorium perfoliatum	boneset	fairly common along shores and in damp areas on ski slopes
Eupatorium rugosum	white snakeroot	reported by Wallace et al. 1979 and by Choiniere
Euthamia graminifolia	lance-leaved goldenrod	common in thickets and along roadsides
Gnaphalium uliginosum*	low cudweed	fairly common in disturbed open ground
Helenium flexuosum*	purple-headed	reported by Wallace et al. 1979
Hieracium aurantiacum*	orange hawkweed	fairly common in clearings and along roadsides
Hieracium caespitosum*	field hawkweed	common in lawns and clearings
Hieracium kalmii	Canada hawkweed	uncommon in open ground on summit
Hieracium paniculatum	panicled hawkweed	reported by Choiniere from dry woods along Harrington Trail
Hieracium pilosella*	mouse ear	fairly common in lawns
Hieracium piloselloides*	smooth hawkweed	common along roadsides and woodland borders

Krigia virginica	dwarf dandelion	reported by Vanasse et al. 1998
Lactuca biennis	tall blue lettuce	fairly common along woodland edges and roadsides
Lactuca canadensis	wild lettuce	fairly common along roadsides and woodland borders
Leontodon autumnalis*	fall dandelion	uncommon in lawns and along roadsides
Matricaria matricarioides	pineapple weed	common in disturbed open ground
Prenanthes alba	white lettuce	reported by Wallace et al. 1979, presumably a misidentification of one of the two other species in this genus
Prenanthes altissima	tall white lettuce	common in mesic woods
Prenanthes trifoliolata	gall-of-the-earth	fairly common in clearings and along woodland borders
Rudbeckia hirta	black-eyed Susan	common in dry clearings and in disturbed open ground
Senecio aureus	golden ragwort	fairly common along shady streams
Solidago arguta	sharp-leaved goldenrod	common along woodland borders, especially in dry soil
Solidago bicolor	silverrod	fairly common in dry thickets
Solidago caesia	blue-stemmed goldenrod	fairly common in rich woods
Solidago canadensis	Canada goldenrod	common in thickets and on open ski slopes
Solidago flexicaulis	zigzag goldenrod	fairly common in rich woods
Solidago juncea	early goldenrod	common in open ground
Solidago nemoralis	gray goldenrod	reported by Choiniere as uncommon in dry pastures along Westminster Road
Solidago puberula	downy goldenrod	common in open ground
Solidago rugosa	rough-stemmed goldenrod	common in thickets and open ground
Solidago squarrosa	stout goldenrod	reported by Wallace et al. 1979 but presumably misidentified as Seymour (1979) does not record this species for the county
Solidago uliginosa	swamp goldenrod	fairly common in swamps
Sonchus arvensis	field sow thistle	uncommon on open ski
Taraxacum officinale*	common dandelion	fairly common along roadsides and in dirt roads
Tragopogon pratensis*	yellow goatsbeard	rare in disturbed open ground
Tussilago farfara*	coltsfoot	uncommon in disturbed open ground

Balsaminaceae

Impatiens capensis	jewelweed	common in moist woods

Berberidaceae

Berberis thunbergii*	Japanese barberry	common in woods and along woodland edges, especially in less acid soils
Caulophyllum thalictroides	blue cohosh	common in rich woods

Betulaceae

Alnus incana	speckled alder	reported by Choiniere from water margins
Betula alleghaniensis	yellow birch	common in woods, especially in wetter soils and on north side of mountain
Betula lenta	sweet birch	fairly common in woods
Betula papyrifera	white birch	common in woods
Betula populifolia	gray birch	fairly common in thickets and early successional woods
Carpinus caroliniana	ironwood	reported by Wallace et al. 1979
Corylus americana	American hazelnut	reported by Vanasse et al. 1998
Corylus cornuta	beaked hazelnut	fairly common in thickets and woods
Ostrya virginiana	hornbeam	common in moist woods

Brassicaceae

Arabis glabra	tower mustard	fairly common along roadside
Barbarea vulgaris*	yellow rocket	uncommon in disturbed open ground near summit
Berteroa incana*	hoary alyssum	uncommon in disturbed open ground
Capsella bursa-pastoris*	shepherd's purse	uncommon in open ground on summit
Cardamine parviflora	small-flowered bitter cress	uncommon in rocky open woods
Cardamine pensylvanica	Pennsylvania bitter-cress	fairly common along streams
Erysimum cheiranthoides*	wormseed mustard	uncommon in disturbed open ground at summit
Lepidium virginicum	wild peppergrass	common on fill in ski area parking lot
Rorippa palustris*	common yellow cress	uncommon in disturbed open ground on summit
Thlaspi arvense*	field pennycress	uncommon in disturbed open ground on summit

Callitrichaceae

Callitriche palustris		reported by Philbrick from the summit pond; records of C.anceps were probably misidentifications of this species

Campanulaceae

Campanula aparinoides	marsh bellflower	reported by Wallace et al. 1979
Lobelia inflata	indian tobacco	common along dirt roads

Caprifoliaceae

Diervilla lonicera	bush honeysuckle	common in dry woods and thickets
Lonicera canadensis	American fly honeysuckle	common in mesic, often rocky, woods
Lonicera morrowii*	Morrow's honeysuckle	one individual seen in [what]
Sambucus canadensis	common elderberry	common in thickets and along roadsides
Sambucus racemosa	red elderberry	common in rocky woods and on boulder slopes
Viburnum acerifolium	maple-leaved viburnum	common in woods; the report of V. edule by Wallace et al. 1979 is presumably a misidentification of this species or V. opulus
Viburnum alnifolium	hobblebush	common in moist woods
Viburnum dentatum	arrowwood	common in swamps
Viburnum lentago	nannyberry	reported by Vanasse et al. 1998
Viburnum nudum	withe-rod	fairly common in thickets and wet woods

Caryophyllaceae

Arenaria groenlandica	mountain sandwort	formerly present, apparently extirpated
Cerastium vulgatum*	mouse-ear chickweed	reported by Choiniere
Dianthus armeria*	Deptford pink	reported by Wallace et al. 1979
Dianthus barbatus*	sweet william	a few individuals in clearing at bottom of
Mountain House Trail		
Dianthus deltoides*	maiden pink	reported by Wallace et al. 1979
Saponaria officinalis*	soapwort	reported by Choiniere from roadsides and
edges of ski slopes		
Scleranthus annuus*	knawel	common in lawns
Silene latifolia*	white campion	fairly common in thickets and clearings
Silene vulgaris*	bladder campion	reported by Wallace et al. 1979
Stellaria graminea*	lesser stitchwort	common in disturbed open ground
Stellaria media*	common chickweed	common in lawns

Cistaceae

Helianthemum canadense	frostweed	common in dry field
Lechea intermedia	intermediate pinweed	common in dry field

Clethraceae

Clethra alnifolia	sweet pepperbush	reported by Choiniere from margins of pools and boggy areas along Dickens Trail

Clusiaceae

Hypericum canadense	Canada St. Johnswort	uncommon in moist open ground
Hypericum gentianoides	orange grass	common in fill at ski area parking lot
Hypericum mutilum	dwarf St. Johnswort	reported by Wallace et al. 1979
Hypericum perforatum*	common St. Johnswort	fairly common in thickets and open ground
Hypericum punctatum	spotted St. Johnswort	uncommon along pond margins
Triadenum virginicum	marsh St. Johnswort	common along pond margins

Convolvulaceae

Calystegia sepium	hedge bindweed	uncommon in summit thickets

Cornaceae

Cornus alternifolia	alternate-leaved dogwood	in woods, especially mesic
Cornus canadensis	bunchberry	fairly common in woods
Cornus florida	flowering dogwood	reported by Wallace et al. 1979
Cornus racemosa	gray-stemmed dogwood	reported by Choiniere as uncommon in dry fields
Cornus rugosa	round-leaved dogwood	reported by Wallace et al. 1979
Cornus sericea	red osier dogwood	reported by Wallace et al. 1979
Nyssa sylvatica	black gum	uncommon in open woods and among rock outcrops

Crassulaceae

Sedum acre*	mossy stonecrop	reported by Wallace et al. 1979
Sedum purpureum*	live-forever	uncommon along roadsides

Cuscutaceae

Cuscuta gronovii	dodder	common in moist thickets

Droseraceae

Drosera intermedia	spatulate-leaved sundew	common in bog and along pond margins
Drosera rotundifolia	round-leaved sundew	fairly common in bog, along pond margins and at moist spots in open ski trails

Ericaceae

Epigaea repens	trailing arbutus	fairly common in dry open areas
Gaultheria procumbens	wintergreen	common in woods
Kalmia angustifolia	sheep laurel	common in bogs, moist woods and along shores
Kalmia latifolia	mountain laurel	common in moist woods
Ledum groenlandicum	labrador tea	reported by Wallace et al. 1979
Lyonia ligustrina	maleberry	fairly common along pond margins
Rhododendron canadense	rhodora	common in bog and on margin of Echo Pond
Rhododendron nudiflorum	mountain azalea	common in woods and thickets
Rhododendron viscosum	clammy azalea	reported by Wallace et al. 1979
Vaccinium angustifolium	common lowbush	common in woods, especially oak woodland
Vaccinium corymbosum	highbush blueberry	common in moist woods and along shores
Vaccinium macrocarpon	large cranberry	uncommon in moist spots on open ski slopes
Vaccinium pallidum	late low blueberry	reported by Vanasse et al. 1998
Vaccinium vitis-idea	mountain cranberry	formerly present, apparently extirpated

Fabaceae

Amphicarpaea bracteata	hog peanut	common in moist thickets and woods
Apios americana	ground nut	common in clearings and thickets
Coronilla varia*	crown vetch	reported by Wallace et al. 1979
Desmodium glutinosum	pointed-leaved tick trefoil	reported by Wallace et al. 1979
Lotus corniculatus*	birdsfoot trefoil	fairly common idisturbed open ground at summit
Medicago lupulina*	black medick	fairly common on open ski slopes
Robinia pseudoacacia*	black locust	reported by Wallace et al. 1979
Trifolium arvense*	rabbit-foot clover	common in ski area parking
Trifolium aureum*	hop clover	common in clearings and along woodland borders
Trifolium hybridum*	alsike clover	fairly common in lawns and on open ski slopes
Trifolium pratense*	red clover	fairly common in open ground
Trifolium repens*	white clover	fairly common in lawns and open areas
Vicia cracca*	cow vetch	common in fields; the V. americana reported by Wallace et al. 1979 is presumably a misidentification of this species

Fagaceae

Castanea dentata	American chestnut	in woods
Fagus grandifolia	American beech	abundant in mesic and dry woods
Quercus alba	white oak	reported by Wallace et al. 1979
Quercus coccinea	scarlet oak	reported by Wallace et al. 1979
Quercus rubra	northern red oak	abundant, especially in drier woods
Quercus velutina	black oak	reported by Cogbill from dry woods near summit

Fumariaceae

Corydalis sempervirens	pink corydalis	fairly common on boulder slopes and on outcrops in oak woods
Dicentra cucullaria	Dutchman's breeches	fairly common in rich, rocky woods

Gentianaceae

Gentiana clausa	bottle gentian	the G. andrewsii reported by Wallace et al. is probably this species

Geraniaceae

Geranium maculatum	wild geranium	reported by Wallace et al. 1979
Geranium robertianum	herb robert	common in rocky woods

Grossulariaceae

Ribes cynosbati	prickly gooseberry	uncommon in disturbed
Ribes glandulosum	skunk currant	common on boulder slopes
Ribes hirtellum	smooth gooseberry	uncommon in swamps and rocky woods; R. lacustre reported by Wallace et al. 1979 is presumably a misidentification of this or another species
Ribes sativum	garden red currant	uncommon in woods

Hamamelidaceae

Hamamelis virginiana	witch hazel	abundant in woods, moist to dry

Juglandaceae

Carya cordiformis	bitternut hickory	uncommon in mesic woods
Carya glabra	pignut hickory	uncommon in woods
Carya ovata	shagbark hickory	common in rocky woods
Juglans cinerea	butternut	rare in woods

Lamiaceae

Glechoma hederacea*	gill-over-the-ground	common in lawns and along trails
Lamium amplexicaule*	henbit	recorded by Wallace et al. 1979
Lycopus uniflorus	northern bugleweed	uncommon along shores and in moist open ground
Mentha arvensis*	wild mint	reported by Wallace et al. 1979
Physostegia virginiana	obedient plant	reported by Wallace et al. 1979 but seems unlikely as it is not reported for Worcester County by Seymour (1969)
Prunella vulgaris	self heal	fairly common in disturbed open ground
Satureja vulgaris	wild basil	uncommon in disturbed open ground
Scutellaria lateriflora	mad-dog skullcap	uncommon in swamps and along streams
Stachys palustris*	marsh hedge nettle	one patch seen on open ski slope

Lauraceae

Lindera benzoin	spicebush	reported by Wallace et al. 1979
Sassafras albidum	sassafras	uncommon in woods

Lentibulariaceae

Utricularia radiata	inflated bladderwort	fairly common in ponds

Malvaceae

Malva moschata*	musk mallow	reported by Wallace et al. 1979

Monotropaceae

Monotropa hypopithys	pinesap	reported by Wallace et al. 1979
Monotropa uniflora	indian pipe	fairly common in woods

Myricaceae

Myrica gale	sweet gale	reported by Wallace et al. 1979
Myrica pensylvanica	northern bayberry	fairly common along roadside

Nymphaeaceae

Nuphar variegata	spatterdock	fairly common in pond

Oleaceae

Fraxinus americana	white ash	abundant in rich woods
Fraxinus nigra	black ash	uncommon in swamps
Syringa vulgaris*	lilac	along roadside, probably planted

Onagraceae

Circaea alpina	dwarf enchanter's	reported by Wallace et al. 1979
Circaea lutetiana	enchanter's nightshade	common in mesic woods
Epilobium angustifolium	fireweed	locally common on open ski slopes
Epilobium coloratum	purple-leaved willow herb	reported by Wallace et al. 1979
Epilobium leptophyllum	narrow-leaved willow herb	reported by Wallace et al. 1979
Oenothera biennis	common evening primrose	fairly common in thickets and along roadsides
Oenothera fruticosa*	sundrops	reported by Wallace et al. 1979, but presumably in error

Orobanchaceae

Epifagus virginiana	beechdrops	in beech woods

Oxalidaceae

Oxalis acetosella	common wood sorrel	fairly common in cool woods
Oxalis stricta	common yellow wood	common in lawns and along roadsides

Papaveraceae

Chelidonium majus*	celandine	reported by Choiniere
Sanguinaria canadensis	bloodroot	fairly common in rich woods

Phytolaccaceae

Phytolacca americana	pokeweed	common on fill near ski area parking lot

Plantaginaceae

Plantago lanceolata*	English plantain	reported by Wallace et al. 1979
Plantago major*	common plantain	common in disturbed open ground
Plantago rugelii	red-stemmed plantain	common in lawns and disturbed open ground

Polygalaceae

Polygala paucifolia	fringed polygala	reported by Wallace et al. 1979
Polygala sanguinea	purple milkwort	common on open ski slopes

Polygonaceae

Polygonum aviculare*	doorweed	common along roadsides and in trampled areas
Polygonum cespitosum*		uncommon along wooded
Polygonum cilinode	fringed bindweed	abundant in rocky woods and on boulder slopes
Polygonum convolvulus*	black bindweed	common on fill near ski area parking lot
Polygonum pensylvanicum	pink knotweed	uncommon along roadsides and in open ground
Polygonum persicaria*	lady's thumb	fairly common in disturbed open ground
Polygonum punctatum	dotted smartweed	uncommon in damp open ground
Polygonum sagittatum	arrow-leaved tearthumb	common in wet thicket
Polygonum scandens	climbing false buckwheat	along pond margins
Rumex acetosella*	field sorrel	common in disturbed open ground
Rumex crispus*	curled dock	uncommon in disturbed open ground
Rumex obtusifolius*	bitter dock	uncommon along woodland borders

Portulacaceae

Claytonia caroliniana	spring beauty	locally common in mesic woods

Primulaceae

Lysimachia quadrifolia	whorled loosestrife	common in drier ground
Lysimachia terrestris	swamp candles	common along pond margins and in wet open ground
Trientalis borealis	starflower	common in woods

Pyrolaceae

Chimaphila maculata	spotted wintergreen	reported by Wallace et al. 1979
Chimaphila umbellata	pipsissewa	reported by Wallace et al. 1979
Pyrola elliptica	shinleaf	reported by Wallace et al. 1979
Pyrola rotundifolia	round-leaved pyrola	reported by Wallace et al. 1979; the report by these authors of P. minor is mistaken

Ranunculaceae

Actaea alba	doll's eyes	common in rich woods
Anemone quinquefolia	wood anemone	common in woods
Aquilegia canadensis	wild columbine	uncommon among rock outcrops in woods
Clematis virginiana	virgin's bower	fairly common in moist open woods; C. viorna listed in Wallace et al. 1979 is presumably this species
Coptis trifolia	goldthread	common in moist woods
Hepatica americana	round-lobed hepatica	reported by Choiniere from steep slopes above High Meadow and by Wallace et al. 1979

Ranunculus abortivus	small-flowered crowfoot	common in rocky woods and on boulder slopes
Ranunculus acris*	tall buttercup	fairly common in clearings and on open ski slopes
Ranunculus bulbosus*	bulbous buttercup	common in clearings
Ranunculus recurvatus	hooked crowfoot	fairly common along margins of woodland streams
Thalictrum dioicum	early meadow rue	reported by Wallace et al. 1979
Thalictrum pubescens	tall meadow rue	fairly common in moist woods and thickets

Rosaceae

Agrimonia gryposepala	common agrimony	uncommon in rich woods
Amelanchier arborea	common shadbush	common in dry woods
Amelanchier laevis	smooth shadbush	fairly common in woods
Aronia melanocarpa	black chokeberry	common in clearings and thickets and among rock outcrops
Crataegus coccinea	scarlet hawthorn	uncommon in moist woods
Crataegus flabellata	fanleaf hawthorn	fairly common in dry woods
Fragaria virginiana	wild strawberry	common along roadsides and woodland borders and on open ski slopes
Geum canadense	white avens	fairly common in moist woods and thickets
Potentilla argentea*	silvery cinquefoil	fairly common in lawns and disturbed open ground
Potentilla canadensis	dwarf cinquefoil	common in open ground
Potentilla norvegica	rough cinquefoil	fairly common in disturbed ground on summit
Potentilla recta*	rough-fruited cinquefoil	uncommon in disturbed open ground
Potentilla simplex	common cinquefoil	common along roadsides and in clearings and on open ski slopes
Potentilla tridentata	three-toothed cinquefoil	common among ledges on summit and at overlook
Prunus avium*	sweet cherry	reported by Wallace et al. 1979
Prunus pensylvanica	pin cherry	common in thickets and along woodland borders
Prunus serotina	black cherry	common in woods
Prunus virginiana	choke cherry	common in thickets and along woodland borders
Pyrus malus*	apple	occasional individuals in woods
Rosa carolina	pasture rose	reported by Wallace et al. 1979
Rosa multiflora*	multiflora rose	fairly common along woodland borders
Rubus allegheniensis	common blackberry	common in clearings and along roadsides
Rubus canadensis	smooth blackberry	common in thickets and oak woods near summit
Rubus flagellaris	northern dewberry	common in open ground and along woodland borders
Rubus hispidus	swamp dewberry	abundant in moist woods and clearings

Rubus idaeus	red raspberry	fairly common in thickets
Rubus occidentalis	black raspberry	reported by Wallace et al. 1979
Rubus odoratus	flowering raspberry	fairly common along woodland borders
Rubus pubescens	dwarf raspberry	uncommon along wooded streams
Rubus recurvicaulis	Blanchard's dewberry	uncommon among outcrops and in rocky woods
Sorbus americana	American mountain ash	common in open woods and on boulder slopes
Sorbus decora	northern mountain ash	reported by Wallace et al. 1979
Spiraea alba	meadowsweet	common in thickets and along roadsides
Spiraea tomentosa	steeplebush	fairly common along pond margins

Rubiaceae

Cephalanthus occidentalis	buttonbush	reported by Wallace et al. 1979
Galium asprellum	rough bedstraw	reported by Wallace et al. 1979
Galium mollugo*	wild madder	common in open ground, especially on ski slopes
Galium palustre	marsh bedstraw	common along pond margins
Galium triflorum	sweet-scented bedstraw	common in rich woods
Hedyotis caerulea	bluets	common along trails and woodland borders and in dry open ground
Mitchella repens	partridgeberry	common in woods

Salicaceae

Populus balsamifera*	balsam poplar	reported by Wallace et al. 1979
Populus grandidentata	big-toothed aspen	fairly common in disturbed ground
Populus tremuloides	quaking aspen	reported by Wallace et al. 1979
Salix discolor	pussy willow	one individual in summit thicket
Salix sericea	silky willow	fairly common along pond margin

Saxifragaceae

Chrysosplenium americanum	golden saxifrage	common in swamps
Saxifraga virginiensis	early saxifrage	common in rocky woods
Tiarella cordifolia	foamflower	reported by Choiniere from cool, damp woods

Scrophulariaceae

Agalinis purpurea	purple gerardia	fairly common in wet disturbed ground
Chelone glabra	white turtlehead	reported by Wallace et al. 1979
Linaria canadensis	blue toadflax	common along sandy roadsides

Linaria vulgaris*	butter and eggs	uncommon on barren ground near ski area parking lot
Melampyrum lineare	cow wheat	common in dry woods
Mimulus ringens	monkey flower	the M. alatus reported by Wallace et al. 1979 presumably is this species
Verbascum thapsus*	common mullein	uncommon along roadsides
Veronica officinalis*	common speedwell	fairly common in disturbed open ground
Veronica serpyllifolia*	thyme-leaved speedwell	fairly common in lawns and along dirt roads

Solanaceae

Solanum dulcamara*	deadly nightshade	moist woods and woodland edges

Tiliaceae

Tilia americana	basswood	fairly common in rich mesic woods

Ulmaceae

Ulmus americana	American elm	reported by Wallace et al. 1979

Urticaceae

Laportea canadensis	wood nettle	uncommon in mesic woods

Verbenaceae

Verbena hastata	blue vervain	reported by Wallace et al. 1979

Violaceae

Viola blanda	sweet white violet	fairly common in mesic
Viola cucullata	marsh blue violet	common in swamps
Viola lanceolata	lance-leaved violet	reported by Vanasse et al. 1998 from ski slopes and by Choiniere
Viola macloskeyi	northern white violet	common in swamps and damp places
Viola pubescens	downy yellow violet	fairly common in rich woods; V. canadensis reported by Wallace et al. 1979 is presumably a misidentification of this or some other species
Viola rotundifolia	round-leaved violet	uncommon in cool, moist woods
Viola sagittata	arrow-leaved violet	common in dry clearings and along roadsides
Viola sororia (latiuscula)	broad-leaved wood violet	fairly common in dry woods
Viola sororia (papilionacea)	common blue violet	common along roadsides and in woods

Vitaceae

Parthenocissus quinquefolia	Virginia creeper	common on boulder slopes
Vitis labrusca	fox grape	along woodland margins

4. Monocotyledons

Araceae

Arisaema triphyllum	jack-in-the-pulpit	fairly common in moist and mesic woods

Cyperaceae

Bulbostylis capillaris		common in ski area parking
Carex albicans		fairly common on boulder slopes
Carex arctata		uncommon in mesic woods
Carex brunnescens		common in woods
Carex canescens		abundant in bog
Carex cephalophora		uncommon along trails
Carex communis		uncommon in rocky woods
Carex crinita		uncommon in moist clearing
Carex debilis		common in woods
Carex echinata	star sedge	fairly common in wet open ground
Carex folliculata		fairly common in wet woods and swamps
Carex gracillima		in mesic woods
Carex gynandra		fairly common in wet ground
Carex intumescens		uncommon in swamps
Carex laxiculmis		uncommon in mesic woods
Carex laxiflora		common in woods, especially on richer sites
Carex leptonervia		reported by Vanasse et al. 1998
Carex lurida		common along stream margins and in marshy ground
Carex normalis		fairly common along woodland edges
Carex novae-angliae		uncommon in woods
Carex pallescens		uncommon along woodland edges
Carex pensylvanica		abundant in dry woods
Carex radiata		fairly common in mesic
Carex rosea		fairly common in mesic
Carex scabrata		uncommon in seepy areas along streams
Carex scoparia		common in wet open ground
Carex spicata*		uncommon in thickets
Carex sprengelii		uncommon in rocky woods
Carex stricta		uncommon in swamps
Carex swanii		fairly common in dry to mesic woods
Carex tribuloides		fairly common in damp open ground, including ski slopes
Carex trisperma		fairly common in bog
Carex virescens	ribbed sedge	in woods
Carex vulpinoidea		uncommon along roadsides
Dulichium arundinaceum	three-way sedge	common in marshes and along pond margins
Eleocharis tenuis tenuis		fairly common in moist open ground
Eleocharis tenuis borealis		fairly common in wet open areas and pond margins
Eriophorum virginicum		common in bog

Rhynchospora capitellata	beakrush	fairly common in disturbed open ground at overlook
Scirpus atrovirens	black bullrush	common in damp open ground and along trails
Scirpus cyperinus	wool-grass	fairly common in marshes and along shores
Scirpus microcarpus	barberpole sedge	common in damp areas on open ski slopes

Iridaceae

Iris versicolor	larger blue flag	reported by Wallace et al. 1979 and Vanasse et al. 1998

Juncaceae

Juncus brevicaudatus		fairly common along pond margins and in wet open ground
Juncus bufonius	toad rush	locally common in wet open ground
Juncus canadensis		common along pond margins
Juncus effusus	soft rush	fairly common along shores and in wet open ground
Juncus greenei		uncommon on sandy
Juncus tenuis	path rush	common along trails and in compacted ground
Luzula acuminata		fairly common in woods
Luzula multiflora		fairly common in disturbed dry ground
Luzula parviflora	black-fruited woodrush	presumably extirpated

Liliaceae

Clintonia borealis	blue bead lily	abundant in woods, usually moist or mesic, both oak and ash-maple
Convallaria majalis*	lily of the valley	uncommon in disturbed
Erythronium americanum	trout lily	common in rich, rocky woods
Lilium philadelphicum	wood lily	reported by Wallace et al. 1979
Maianthemum canadense	Canada mayflower	abundant in woods
Medeola virginiana	indian cucumber root	common in woods
Polygonatum pubescens	hairy solomon's seal	common in woods, especially richer sites; the P. biflorum of Vanasse et al. 1998 is this species
Smilacina racemosa	false solomon's seal	common in woods
Streptopus roseus	rose twisted stalk	fairly common in woods
Trillium erectum	red trillium	common in rich, rocky woods
Trillium undulatum	painted trillium	fairly common in cool woods
Uvularia sessilifolia	sessile-leaved bellwort	common in woods

Orchidaceae

Cypripedium acaule	pink lady's slipper	uncommon in dry to mesic woods
Epipactis helleborine*	helleborine	uncommon in moist to mesic woods and along woodland borders
Goodyera pubescens	downy rattlesnake plantain	reported by Choiniere
Habenaria clavellata	green wood orchis	uncommon in swamps
Habenaria lacera	ragged fringed orchis	reported by Wallace et al. 1979

Isotria verticillata	whorled pogonia	reported by Wallace et al. 1979
Pogonia ophioglossoides	rose pogonia	reported by Wallace et al. 1979
Spiranthes cernua	nodding ladies' tresses	reported by Choiniere from bog off Thompson Road

Poaceae

Agrostis canina*	velvet bentgrass	common on open ski slopes
Agrostis capillaris*	Rhode Island bentgrass	common in disturbed ground and open woods near summit
Agrostis gigantea*	redtop	common on open ski slopes, especially in damp areas
Agrostis hyemalis scabra		uncommon along road near summit
Agrostis hyemalis hyemalis	ticklegrass	common in ski area parking
Agrostis stolonifera*	creeping bentgrass	uncommon along pond
Alopecurus pratensis	meadow foxtail	fairly common on open ski slopes, especially in damp ground
Anthoxanthum odoratum*	sweet vernal grass	fairly common in open ground
Arrhenatherum elatius	tall oatgrass	uncommon on open ski
Brachyelytrum erectum		common in woods, especially on moist soils
Bromus inermis*	smooth brome grass	common on ski slopes and other open ground
Calamagrostis canadensis	bluejoint	uncommon in moist open
Cinna latifolia	drooping woodreed	fairly common in rich woods
Dactylis glomerata	orchard grass	fairly common on open ski slopes and along woodland edges
Danthonia compressa		common along trails and in disturbed, open, usually dry, ground
Danthonia spicata	poverty oatgrass	reported by Vanasse et al. 1998
Deschampsia flexuosa	hairgrass	abundant in oak woods at higher elevations and on boulder slopes
Digitaria ischaemum*	smooth crabgrass	common along roadsides and in disturbed open ground
Digitaria sanguinalis*	northern crabgrass	common along roasides and parking areas
Echinochloa muricata	barnyard grass	uncommon in wet open areas
Elymus hystrix	bottlebrush grass	common in rich, rocky woods
Elytrigia repens*	quack grass	fairly common in disturbed open ground at summit
Eragrostis pilosa*		uncommon in barren ground in ski are parking lot
Festuca elatior*	tall fescue	uncommon on open ski
Festuca pratensis*	meadow fescue	reported by Vanasse et al. 1998
Festuca rubra*	red fescue	common in grassy area and along woodland borders
Festuca subverticillata	nodding fescue	common in rocky woods, especially on higher slopes
Glyceria canadensis	rattlesnake mannagrass	common in wet open ground
Glyceria melicaria	northeastern mannagrass	common along wooded streams
Glyceria striata	fowl mannagrass	fairly common in wet thicket

Leersia oryzoides	rice cut grass	uncommon in wet ground near summit pond
Lolium perenne*	ryegrass	fairly common along
Muhlenbergia schreberi	nimblewill	common in lawns
Muhlenbergia uniflora		fairly common on disturbed damp ground
Oryzopsis asperifolia	rough-leaved ricegrass	fairly common in mesic to dry woods
Oryzopsis racemosa	black mountain rice	common in rich, rocky woods
Panicum clandestinum		fairly common along
Panicum dichotomiflorum		fairly common along
Panicum lanuginosum		uncommon in disturbed open ground
Panicum latifolium		fairly common in rocky woods
Panicum oligosanthes		reported by Vanasse et al. 1998
Phalaris arundinacea	reed canary grass	fairly common in damp areas on open ski slopes
Phleum pratense*	timothy	common in clearings and in disturbed open grouns
Poa annua*	speargrass	fairly common in damp open ground
Poa compressa*	Canada bluegrass	common among rock outcrops and along trails, especially in drier ground
Poa palustris	fowl meadow grass	fairly common in damp ground on open ski slope
Poa pratensis*	Kentucky bluegrass	common in lawns and fields
Poa saltuensis		common in oak woods
Schizachyrium scoparium	little bluestem	reported by Vanasse et al. 1998
Setaria glauca*	yellow foxtail	uncommon along roadsides

Pontederiaceae

Eichhornia crassipes*	water hyacinth	several individuals in summit pool in both 1997 and 1998, presumably introduced in both years as the species does not overwinter at this latitude

Potamogetonaceae

Potamogeton epihydrus	ribbonleaf pondweed	uncommon in slow streams

Smilacaceae

Smilax herbacea	carrion flower	uncommon in woods

Sparganiaceae

Sparganium americanum	bur reed	common along pond margins
Sparganium chlorocarpum	bur reed	fairly common along pond margins

Typhaceae

Typha latifolia	cattail	uncommon along pond

APPENDIX F

Wildlife Species of WMSR

Appendix F1 : Mammals Documented or Presumed to Occur within WMSR

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Marsupialia – Marsupials										
Virginia Oppossum[1,3] (*Didelphis virginiana*)	✓	✓	✓				✓		✓	Log or tree cavity
Insectivora – Shrews & Moles										
Masked Shrew[1,3] (*Sorex cinereus*)	✓	✓	✓	✓	✓	✓	✓		✓	Damp woodlands, ground cover
Water Shrew[3] (*Sorex palustris*)	✓	✓		✓	✓	✓	✓	✓		Herbaceous cover, cold-water wetlands
Smoky Shrew[3] (*Sorex fumeus*)	✓	✓		✓	✓	✓	✓			Loose damp leaf litter
Short-tailed Shrew[1,3] (*Blarina brevicauda*)	✓	✓	✓	✓	✓	✓	✓		✓	Low vegetation, damp, loose leaf litter
Hairy-tailed Mole[3] (*Parascalops breweri*)	✓	✓	✓	✓	✓	✓			✓	Loose, moist, well-drained soil
Eastern Mole[3] (*Scalopus aquaticus*)			✓						✓	Soft, moist soils containing earthworms
Star-nosed Mole[3] (*Condylura cristata*)							✓	✓		Wet muck, humus
Chiroptera – Bats										
Little Brown Myotis[1,3] (*Myotis lucifugus*)	✓	✓	✓	✓	✓	✓	✓	✓	✓	Females: dark, warm sites for maternity colonies. Forest openings for feeding
Keen's Myotis[1,3] (*Myotis keenii*)	✓	✓	✓	✓	✓	✓	✓	✓	✓	Caves, mine shafts with temps near 40 F; high relative humidity and calm air
Silver-haired Bat[3] (*Lasionycteris noctivagans*)	✓	✓	✓	✓	✓	✓	✓	✓	✓	Dead trees with loose bark or cavitites; streams

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Conif-erous Forest				
Eastern Pipistrelle[1,3] (*Pipistrellus subflavus*)	✓	✓	✓	✓	✓		✓	✓	✓	Warm, draft-free, damp sites for hibernation, open woods
Big Brown Bat[1,3] (*Eptesicus fuscus*)	✓	✓	✓	✓	✓	✓	✓	✓	✓	Cold, dry areas of caves or buildings for hibernation
Red Bat[3] (*Lasiurus borealis*)	✓	✓	✓		✓		✓	✓	✓	Deciduous trees on forest edges for roosting
Hoary Bat[3] (*Lasiurus cinereus*)	✓	✓	✓	✓	✓	✓	✓	✓	✓	Edges of coniferous forests
Lagomorpha – Rabbits & Hares										
Eastern Cottontail[1,2,3] (*Sylvilagus floridanus*)	✓						✓		✓	Brush piles, stone walls, dens or burrows; herbaceous and shrubby cover
New England Cottontail[1,3] (*Sylvilagus transitionalis*)	✓						✓		✓	Young woodlands with thick cover
Snowshoe Hare[1,2,3] (*Lepus americanus*)	✓	✓	✓	✓	✓	✓	✓		✓	Dense brushy or softwood cover
Rodentia – Rodents										
Eastern Chipmunk[1,2,3] (*Tamias striatus*)	✓	✓	✓	✓	✓	✓			✓	Forest edge or shrub cover, elevated perches, logs
Woodchuck[1,3] (*Marmota monax*)	✓	✓	✓						✓	Open land
Gray Squirrel[1,2,3] (*Sciurus carolinensis*)		✓	✓							Tall trees for dens or leafnests
Red Squirrel[1,2,3] (*Sciurus hudsonicus*)		✓	✓	✓	✓	✓				Woodlands with mature trees, conifers preferred
Southern Flying Squirrel[1,3] (*Glaucomys volans*)		✓	✓							Mature trees, cavities for winter dens; arboreal lichens
Northern Flying Squirrel[1,3] (*Glaucomys sabrinus*)		✓	✓	✓	✓	✓				Mature trees, cavities for winter dens; arboreal lichens
Beaver[1,3] (*Castor canadensis*)	✓	✓	✓				✓	✓		Woodland streams, lack of disturbance

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Deer Mouse[1,3] (*Peromyscus maniculatus*)	✓	✓	✓	✓	✓	✓				Northern hardwoods or northern coniferous forests
White-footed Mouse[1,3] (*Peromyscus leucopus*)	✓	✓	✓	✓	✓	✓	✓		✓	
Southern Red-backed Vole[1,3] (*Clethrionomys gapperi*)	✓	✓	✓	✓	✓	✓	✓		✓	Springs, brooks, seeps, bogs; debris or slash cover.
Meadow Vole[1,3] (*Microtus pennsylvanicus*)	✓						✓		✓	Herbaceous vegetation, loose organic soils
Woodland Vole[3] (*Microtus pinetorum*)	?	✓	✓						✓	Ground cover of leaves or grass; moist well-drained soils
Muskrat[1,2,3] (*Ondatra zibethicus*)							✓	✓		Wetlands with dense emergent vegetation; stable water level
Southern Bog Lemming[3] (*Synaptomys cooperi*)	✓	✓	✓				✓		✓	Moist to wet loose soils or leaf mulch
Norway Rat[1,3] (*Rattus norvegicus*)									✓	Buildings, dumps or loose soil for digging burrows
House Mouse[1,3] (*Mus musculus*)									✓	Buildings in winter
Meadow Jumping Mouse[1,3] (*Zapus hudsonius*)	✓						✓		✓	Herbaceous groundcover, loose soils
Woodland Jumping Mouse[3] (*Napaeozapus insignis*)	✓	✓	✓	✓	✓	✓	✓			Moist cool woodland, loose soils, herbaceous cover
Porcupine[1,2,3] (*Erethizon dorsatum*)	✓	✓	✓	✓	✓	✓	✓		✓	Rock ledges or den trees
Carnivora – Carnivores										
Coyote[3] (*Canis latrans*)	✓	✓	✓	✓	✓	✓	✓		✓	
Red Fox[1,3] (*Vulpes vulpes*)	✓	✓	✓	✓	✓	✓	✓		✓	
Gray Fox[1,3] (*Urocyon cinereoargenteus*)	✓	✓	✓			✓	✓		✓	Hollow logs, tree cavities, rock crevices

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Conif-erous Forest				
Black Bear[1,3] *(Ursus americanus)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	Fallen trees, hollow logs, rock ledges, slash piles
Raccoon[1,3] *(Procyon lotor)*	✓	✓	✓	✓	✓	✓	✓		✓	Hollow trees, dens usually located 10 ft. or more above ground
Fisher[3] *(Martes pennanti)*	✓	✓	✓	✓	✓	✓	✓			Hollow trees, logs
Ermine[1,3] *(Mustela erminea)*	✓	✓	✓	✓	✓	✓	✓		✓	Dense brushy cover, slash
Long-tailed Weasel[1,3] *(Mustela frenata)*	✓	✓	✓	✓	✓	✓	✓		✓	
Mink[1,3] *(Mustela vison)*	✓	✓	✓	✓	✓	✓	✓	✓		Hollow logs, natural cavities, under tree roots, riparian habitat
Striped Skunk[1,3] *(Mephitis mephitis)*	✓	✓	✓	✓	✓	✓	✓		✓	
River Otter[1,3] *(Lutra canadensis)*	✓	✓	✓	✓	✓	✓	✓	✓		Body of water such as stream, pond, lake, river
Felidae – Cats										
Bobcat[1,3] *(Felis rufus)*	✓	✓	✓	✓	✓	✓	✓		✓	Rock ledges, under windfalls or in hollow logs
Artiodactyla – Deer & Moose										
White-tailed Deer[1,2,3] *(Odocoileus virginianus)*	✓	✓	✓	✓	✓	✓	✓		✓	Softwood yarding cover in North
Moose[1,3] *(Alces alces)*	✓	✓	✓	✓	✓	✓	✓	✓		Wetlands (in summer)

Sources:

1. DEM. 1979. Wachusett Mountain State Reservation Draft Management Plan.
2. VHB. 1998. Wachusett Mountain Ski Area Improvements, Final Environmental Impact Report, EOEA No. 9690. Prepared on behalf of Wachusett Mountain Associates.
3. Degraff, R.M and D. Rudis. 1983 New England Wildlife: Habitat, Natural History, and Distribution. U.S. Forest Service.
4. Epsilon Associates, Inc. 1998. Wachusett Mountain Summit Natural and Cultural Resources Inventory and Analysis. Report commissioned by DEM (NB: report incorporates faunal survey conducted by Oxbow Associates)

Appendix F2 : Birds Documented or Presumed to Occur within WMSR

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Gaviidae – Loons										
Common Loon[1,3] *(Gavia immer)*				✓				✓		Large undisturbed bodies of water with stable water levels and islands
Podicipedidae – Grebes										
Pied-billed Grebe[3] *(Podilymbus podiceps)*							✓	✓		Marshes with water and emergent vegetation
Phalacrocoracidae – Cormorants										
Double-crested Cormorant[1,3] *(Phalacrocorax auritus)*								✓		
Ardeidae – Bitterns & Herons										
American Bittern[3] *(Botaurus lentiginosus)*							✓	✓		Undisturbed tall marsh vegetation
Least Bittern[3] *(Ixobrychus exilis)*							✓	✓	✓	Deep marshes with clumps of emergent vegetation
Great Blue Heron[1,3] *(Ardea herodias)*							✓	✓		Undisturbed rookery, tall trees
Green Heron[1,3] *(Butorides virescens)*							✓	✓		
Black-crowned Night-heron[3] *(Nycticorax nycticorax)*							✓	✓		
Cathartidae – Vultures										
Turkey Vulture[1,3,4] *(Cathartes aura)*	✓	✓	✓		✓				✓	Forest clearings
Anatidae – Geese, Swans & Ducks							✓	✓	✓	

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Canada Goose[1,2,3,4] *(Branta canadensis)*							✓	✓		
Wood Duck[1,2,3,4] *(Aix sponsa)*							✓	✓		Trees at least 16″ dbh w/ large cavities and 4″dm. Entrance holes
American Black Duck[1,3,4] *(Anas rubripes)*							✓	✓		Wooded wetlands, stream banks
Hooded Merganser[3] *(Lophodytes cucullatus)*		✓		✓	✓	✓	✓	✓		Undisturbed wooded areas with cavity trees (15″dbh min.); clear fresh water
Mallard[1,3] *(Anas platyrhynchos)*							✓	✓	✓	
Accipitridae – Kites, Eagles & Hawks										
Osprey[1,3] *(Pandion haliaetus)*								✓		Clear lakes, rivers containing fish
Northern Harrier[1,3] *(Circus cyaneus)*							✓	✓	✓	Marshes or open country with low vegetation
Sharp-shinned Hawk[1,3] *(Accipiter striatus)*	✓	✓	✓	✓	✓	✓				Extensive undisturbed open mixed woodlands
Cooper's Hawk[1,2,3] *(Accipiter cooperii)*	✓	✓	✓							
Northern Goshawk[1,3,4] *(Accipiter gentilis)*	✓	✓	✓	✓	✓	✓			✓	Extensive mature mixed woodlands
Red-shouldered Hawk[1,3] *(Buteo lineatus)*	✓	✓	✓		✓		✓			Cool, moist, mature forest, wooded wetlands
Broad-winged Hawk [1,2,3,4] *(Buteo platypterus)*	✓	✓	✓	✓					✓	Extensive woodlands with roads or clearings
Red-tailed Hawk[1,3,4] *(Buteo jamaicensis)*	✓	✓	✓	✓					✓	Mature forest-field ecotone
Rough-legged Hawk[1,3] *(Buteo lagopus)*							✓		✓	Open country

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Falconidae – Falcons										
American Kestrel[1,3] *(Falco sparverius)*	✓	✓	✓		✓		✓		✓	Tall trees with cavities (dbh at least 12"); open country with low relief
Merlin[1,3] *(Falco columbarius)*						✓	✓		✓	Natural cavities or old woodpecker holes in open woodlands
Peregrine Falcon[1,3] *(Falco peregrinus)*	✓	✓	✓	✓	✓	✓	✓		✓	High cliffs
Phasianidae – Pheasants & Turkeys										
Ring-necked Pheasant[3] *(Phasianus colchicus)*									✓	Cultivated fields, farmland
Ruffed Grouse[1,3] *(Bonasa umbellus)*	✓	✓	✓	✓	✓	✓			✓	Fallen logs amidst dense saplings
Wild Turkey[2,3] *(Meleagris gallopavo)*	✓	✓	✓	✓	✓				✓	Open, mast producing woodlands, large conifers for roosting, woodland clearings
Odontophoridae – Quail										
Northern Bobwhite[3] *(Colinus virginianus)*	✓				✓				✓	Brushy field edges, well-drained sandy or loamy solis
King Rail[3] *(Rallus elegans)*							✓			Stable water levels
Virginia Rail[3] *(Rallus limicola)*							✓			Wetlands with sedge and cattails
Sora[3] *(Porzana carolina)*							✓			
Charadriidae – Plovers & Lapwings										
Killdeer[1,3,4] *(Charadrius vociferus)*							✓		✓	Bare ground, sparse vegetation

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Conif-erous Forest				
Scolopacidae – Sandpipers & Allies										
American Woodcock[1,2,3] *(Scolopax minor)*	✓	✓			✓	✓	✓		✓	Fertile moist soil containing earthworms, clearings and dense swales
Laridae – Gulls, Terns & Allies										
Herring Gull[1,3] *(Larus argentatus)*								✓		
Columbidae – Pigeons & Doves										
Rock Dove[1,3] *(Columba livia)*									✓	
Mourning Dove[1,3,4] *(Zenaida macroura)*	✓	✓	✓	✓	✓				✓	Open land with bare ground
Cuculidae – Cuckoos & Allies										
Black-billed Cuckoo[1,3,4] *(Coccyzus erythropthalmus)*	✓	✓	✓		✓	✓	✓		✓	Low, dense thickets
Yellow-billed Cuckoo[1,3] *(Coccyzus americanus)*	✓	✓	✓						✓	Low, dense thickets
Tytonidae – Barn Owls										
Barn Owl[3] *(Tyto alba)*									✓	Barns, silos, deserted buildings, tree cavities
Strigidae – Typical Owls										
Eastern Screech Owl[3] *(Otus asio)*	✓	✓	✓	✓	✓		✓		✓	Cavity trees (12″ dbh minimum)
Great Horned Owl[1,3] *(Bubo virginianus)*	✓	✓	✓	✓	✓	✓	✓		✓	Large abandoned hawk nests, large tree cavities
Barred Owl[1,3] *(Strix varia)*	✓	✓	✓	✓	✓	✓		✓	✓	Cool, damp lowlands; cavity trees with minimum dbh of 20″
Long-eared Owl[3] *(Asio otus)*	✓	✓	✓	✓	✓	✓	✓		✓	Dense conifer thickets in open country

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Short-eared Owl[3] *(Asio flammeus)*							✓		✓	Extensive open grasslands, dunes
Northern Saw-whet Owl[3] *(Aegolius funereus)*	✓	✓	✓	✓	✓	✓			✓	Cavity trees with minimum dbh of 12″ near forest clearings
Caprimulgidae – Goatsuckers										
Common Nighthawk[1,3] *(Chordeiles minor)*	✓	✓	✓	✓	✓	✓	✓		✓	
Whip-poor-will[1,3] *(Caprimulgus carolinensis)*	✓	✓	✓		✓				✓	Ungrazed woodlands with openings
Apodidae – Swifts										
Chimney Swift[1,3] *(Chaetura pelagica)*							✓		✓	Chimmneys
Trochilidae – Hummingbirds										
Ruby-throated Hummingbird[1,3] *(Archilochus colubris)*	✓	✓	✓	✓	✓	✓			✓	Flowers, preferably red
Alcedinidae – Kingfishers										
Belted Kingfisher[1,3,4] *(Ceryle alcyon)*								✓		Perches over streams, ponds; banks for nest sites
Picidae – Woodpeckers										
Red-bellied Woodpecker[3] *(Melanerpes carolinus)*	✓		✓		✓				✓	Extensive mature woodlands with dead trees or trees with large dead limbs
Red-headed Woodpecker[1,3] *(Melanerpes erythrocephalus)*									✓	Cavity trees in savanna or open country
Yellow-bellied Sapsucker[1,2,3,4] *(Sphyrapicus varius)*	✓	✓	✓	✓	✓	✓				Trees with minimal dbh of 10″ especially aspens containing sound decayed wood
Downy Woodpecker[1,2,3,4] *(Picoides pubescens)*	✓	✓	✓	✓	✓	✓	✓			Trees, limbs with decay column (minimum dbh 6″)
Hairy Woodpecker[1,2,3] *(Picoides villosus)*	✓	✓	✓	✓	✓	✓				Trees, limbs with decay column (minimum dbh 10″)

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Northern Flicker[1,2,3,4] *(Colaptes auratus)*	✓	✓	✓	✓	✓	✓			✓	Open areas; trees with column of decayed wood (min dbh 12″) forest edges
Pileated Woodpecker[1,2,3,4] *(Dryocopus pileatus)*	✓	✓	✓	✓	✓	✓				Mature forest; trees with column of decayed wood at least 20″ dbh
Tyrannidae – Tyrant Flycatchers										
Olive-sided Flycatcher[1,3,4] *(Contopus cooperi)*				✓	✓	✓	✓	✓		Low, wet coniferous forest, bog, etc. with high song perch
Eastern Wood-Pewee[1,2,3,4] *(Contopus virens)*	✓	✓	✓	✓	✓	✓	✓			Forest edge or open woods
Yellow-bellied Flycatcher[1,3] *(Empidonax flaviventris)*		✓		✓	✓	✓	✓			Low, wet coniferous forest
Alder Flycatcher[1,3] *(Empidonax alnorum)*	✓	✓	✓	✓	✓	✓	✓			Thickets, low shrubs and clearings
Willow Flycatcher[3,4] *(Empidonax traillii)*	✓	✓	✓							Low deciduous trees and shrubs with clearings, thick hardwood seedlings
Least Flycatcher[1,2,3,4] *(Empidonax minimus)*	✓	✓	✓			✓			✓	Open deciduous or mixed forest, edges
Eastern Phoebe[3,4] *(Sayornis phoebe)*	✓	✓	✓	✓	✓	✓			✓	Exposed perches; cliffs or ledges in streamside clearings, woodland edges
Great Crested Flycatcher[1,2,3,4] *(Miachus cinerascens)*	✓	✓	✓	✓	✓	✓			✓	Mature cavity trees, deciduous forest, edges
Eastern Kingbird[3,4] *(Tyrannus tyrannus)*	✓	✓	✓						✓	Clearings, fields, orchards
Laniidae – Shrikes										
Northern Shrike[3] *(Lanius excubitor)*	✓	✓	✓	✓	✓	✓				Scattered trees or shrubs in open country
Vireonidae – Vireos										

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Solitary Vireo[1,2,3,4] *(Vireo solitarius)*	✓	✓	✓	✓	✓	✓				Mixed or predominantly coniferous woodland
Yellow-throated Vireo[3,4] *(Vireo flavifrons)*	✓	✓	✓						✓	Mature deciduous forest
Warbling Vireo[1,3] *(Vireo gilvus)*	✓	✓	✓						✓	Scattered deciduous trees, shade trees
Philadelphia Vireo[1,3] *(Vireo philadelphicus)*	✓	✓	✓						✓	Hardwood forest edges
Red-eyed Vireo[1,2,3,3] *(Vireo olivaceus)*	✓	✓	✓	✓	✓	✓				
Corvidae – Jays & Crows										
Blue Jay[1,2,3,4] *(Cyanocitta cristata)*	✓	✓	✓	✓	✓	✓			✓	
American Crow[1,2,3,4] *(Corvus brachyrhynchos)*	✓	✓	✓	✓	✓	✓			✓	
Alaudidae – Larks										
Horned Lark[1,3] *(Eremophila alpestris)*									✓	Bare, exposed soil
Hirundinidae – Swallows										
Purple Martin[1,3] *(Progne subis)*	✓						✓		✓	Martin houses near ponds, lakes
Tree Swallow[3,4] *(Tachycineta bicolor)*	✓						✓		✓	Cavity trees (min dbh 10") open areas, especially near water
N. Rough-winged Swallow[1,3] *(Stelgidopteryx serripennis)*	✓						✓		✓	Sandy or clay banks stabilized by a grassy, overhanging top
Bank Swallow[1,3] (Riparia *riparia)*	✓						✓		✓	Sandy or clay banks stabilized by a grassy overhang
Cliff Swallow[1,3] *(Petrochelidon pyrrhonota)*	✓						✓		✓	Open areas; mud; vertical wall with an overhang
Barn Swallow[1,3,4] *(Hirundo rustica)*	✓						✓		✓	Abandoned or little-used buildings
Paridae – Titmice										

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Black-capped Chickadee[1,2,3,4] *(Poecile atricapillus)*	✓	✓	✓	✓	✓	✓			✓	Cavity trees or stubs in small woodlands; clearings or open woodlands
Tufted Titmouse[1,2,3,4] *(Baeolophus bicolor)*	✓	✓	✓		✓					Cavity trees at least 8″ dbh
Sittidae – Nuthatches										
Red-breasted Nuthatch[1,3] *(Sitta canadensis)*		✓		✓	✓	✓				Cavity trees in mixed or coniferous woods (min dbh 12″)
White-breasted Nuthatch[1,2,3] *(Sitta carolinensis)*	✓	✓	✓		✓					Cavity trees in hardwoods or mixed woods (min dbh 12″)
Certhiidae – Creepers										
Brown Creeper[1,2,3,4] *(Certhia americana)*	✓	✓	✓	✓	✓	✓				Woodlands containing trees with sloughing or loose bark
Troglodytidae – Wrens										
Carolina Wren[3] *(Thryothorus ludovicianus)*	✓		✓							Cavity trees amid brushy vegetation, thickets, swamps
House Wren[1,3] *(Troglodytes aedon)*	✓	✓	✓							Cavity trees, shrubs
Winter Wren[1,3,4] *(Troglodytes troglodytes)*	✓	✓	✓	✓	✓	✓	✓			Moist, mixed or coniferous woodlands with down logs; low woody vegetation
Regulidae – Kinglets										
Golden-crowned Kinglet[1,3] *(Regulus satrapa)*	✓	✓		✓	✓	✓				Dense conifer thickets or stands, especially spruce
Ruby-crowned Kinglet[1,3] *(Regulus calendula)*	✓			✓	✓	✓				Conifer stands, or mixed stands with a predominance of softwoods, especially spruce or fir
Silviidae – Gnatcatchers										
Blue-gray Gnatcatcher[1,3,4] *(Polioptila caerulea)*	✓	✓	✓						✓	Open deciduous woodland

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Turdidae – Bluebirds & Thrushes										
Eastern Bluebird[1,3] *(Sialia sialis)*	✓	✓	✓		✓				✓	Low cavities, open country
Veery[1,3,4] *(Catharus fuscescens)*	✓	✓	✓	✓	✓	✓				Moist woodlands with understory of low trees and shrubs
Gray-cheeked Thrush[1,3] *(Catharus minimus)*						✓				Young coniferous forest at high elevations
Swainson's Thrush[1,3] *(Catharus ustulatus)*		✓		✓	✓	✓				Coniferous or mixed forest
Hermit Thrush[1,2,3,4] *(Catharus guttatus)*	✓	✓	✓	✓	✓	✓	✓			Coniferous or mixed woodlands with dense undergrowth
Wood Thrush[1,2,3,4] *(Hylocichla mustelina)*	✓	✓	✓	✓	✓	✓				Cool, moist, mature deciduous or mixed forest
American Robin[1,2,3,4] *(Turdus migratorius)*	✓	✓	✓	✓	✓	✓	✓		✓	
Mimidae – Mimic Thrushes										
Gray Catbird[1,3,4] *(Dumetella carolinensis)*	✓	✓	✓		✓				✓	Shrubs, thickets in open country or forest understory
Northern Mockingbird[1,3] *(Mimus polyglottos)*	✓								✓	Low thickets; high perches; persistent fruits
Brown Thrasher[1,3] *(Toxostoma rufum)*	✓	✓	✓		✓				✓	Hardwood forest-field ecotone
Sturnidae – Starlings										
European Starling[1,3] *(Sturnus vulgaris)*	✓	✓	✓	✓	✓		✓		✓	Cavity trees with 10″ min dbh
Bombycilldae – Waxwings										
Cedar Waxwing[1,3,4] *(Bombycilla garrulus)*	✓	✓	✓		✓		✓		✓	Open country with scattered trees, thickets with persistent fruits (winter)
Parulidae – Wood Warblers										

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Blue Winged Warbler[1,3] *(Vermivora pinus)*	✓	✓	✓				✓			Old fields with scattered shrubs and small trees
Golden-winged Warbler[1,3] *(Vermivora chrysoptera)*	✓	✓	✓							Open areas with saplings in deciduous woodlands
Tennessee Warbler[1,3] *(Vermivora peregrina)*	✓	✓	✓	✓	✓	✓	✓			Brushy, semi-open country
Orange-crowned Warbler[1,3] *(Vermivora celata)*	✓	✓	✓							
Nashville Warbler[1,2,3] *(Vermivora ruficapilla)*	✓	✓	✓	✓	✓	✓	✓			Scattered trees interspersed with brush, thickets, slash
Northern Parula[1,3] *(Parula americana)*	✓	✓	✓	✓		✓	✓			Presence of bearded lichen
Yellow Warbler[1,3,4] *(Dendroica petechia)*	✓	✓	✓		✓	✓	✓			Scattered small trees or dense shrubs, esp. near water
Chestnut-sided Warbler[1,2,3,4] *(Dendroica pensylvanica)*		✓					✓		✓	Sprouts and brush at wood margins; hardwoods seedling stands
Magnolia Warbler[1,2,3] *(Dendroica magnolia)*				✓		✓				Young stands of spruce or fir, sometimes of hemlock
Cape May Warbler[1,3] *(Dendroica tigrina)*					✓	✓				Spruce forest
Black-throated Blue Warbler[1,3,4] *(Dendroica caerulescens)*	✓	✓	✓	✓		✓				Hardwood or mixed woodalnds with well-developed understory
Yellow-rumped Warbler[1,3] *(Dendroica coronata)*	✓	✓	✓	✓	✓	✓	✓			Coniferous trees (summer), bayberry thickets (winter)
Black-throated Green Warbler[1,3,4] *(Dendroica virens)*	✓	✓	✓	✓	✓	✓				Coniferous or mixed woodlands
Blackburnian Warbler[1,3] *(Dendroica fusca)*		✓	✓	✓		✓				Coniferous forest, mixed woodlands

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Pine Warbler[1,3] *(Dendroica pinus)*	✓				✓					Pine forest
Prarie Warbler[1,3] *(Dendroica discolor)*	✓	✓	✓		✓				✓	Coniferous cover in old fields, hardwood saplings, slash
Palm Warbler[1,3] *(Dendroica palmarum)*	✓			✓	✓	✓	✓			Scattered trees, thick shrub growth
Blackpoll Warbler[1,3] *(Dendroica striata)*		✓		✓		✓				Stunted spruce, especially at high elevations
Cerulean Warbler[3,4] *(Dendroica cerulea)*	✓									Mature deciduous woodland
Black-and-white Warbler[1,2,3,4] *(Mniotilta varia)*	✓	✓	✓	✓	✓	✓				
American Redstart[1,2,3,4] *(Setophaga ruticilla)*	✓	✓	✓	✓	✓	✓				
Ovenbird[1,2,3,4] *(Seiurus aurocapillus)*	✓	✓	✓	✓	✓	✓				
Northern Waterthrush[1,3] *(Seiurus noveboracensis)*		✓	✓	✓	✓	✓	✓	✓		Cool, shaded, wet ground with shallow pools
Mourning Warbler[1,3] *(Oporornis philadelphia)*		✓	✓			✓	✓			Extensive stands hardwood regeneration
Common Yellowthroat[1,2,3,4] *(Geothlypis trichas)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Wilson's Warbler[1,3] *(Wilsonia pusilla)*		✓	✓	✓	✓		✓			Cold shrub swamps, bogs
Canada Warbler[1,2,3,4] *(Wilsonia canadensis)*	✓	✓	✓	✓	✓	✓	✓			Dense deciduous or ericaceous understory
Yellow –breasted Chat[3] *(Icteria virens)*	✓	✓	✓		✓				✓	Dense thickets and vines with scattered young trees, often neat water
Thraupidae – Tanagers										
Scarlet Tanager[1,2,3,4] *(Piranga rubra)*	✓	✓	✓	✓	✓					

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Emberizidae – Sparrows & Allies										
Rufous–sided Towhee[1,2,3,4] *(Pipilo erythrophthalmus)*	✓	✓	✓		✓					Dense, brushy understory, well-drained soils
American Tree Sparrow[1,3] *(Spizella arborea)*	✓	✓	✓	✓	✓	✓	✓		✓	Open country, weed fields (winter)
Chipping Sparrow[3,4] *(Spizella passerina)*	✓	✓	✓	✓	✓	✓			✓	Clearings with bare ground, conifers or thorny shrubs
Field Sparrow[1,3] *(Spizella pusilla)*	✓								✓	Old fields
Vesper Sparrow[1,3] *(Pooecetes gramineus)*							✓		✓	Open country with short, herbaceous vegetation; conspicuous perches
Savannah Sparrow[1,3] *(Passerculus sandwichensis)*							✓		✓	Herbaceous cover of moderate height
Fox Sparrow[1,3] *(Passerella iliaca)*	✓									
Song Sparrow[1,2,3,4] *(Melospiza melodia)*	✓	✓	✓	✓	✓	✓	✓		✓	
Lincoln's Sparrow[1,3] *(Melospiza lincolnii)*		✓		✓	✓	✓	✓			Brushy thickets 4 to 8 feet high with grass or sedge openings
Swamp Sparrow[1,3,4] *(Melospiza georgiana)*						✓	✓	✓		
White-throated Sparrow[1,2,3,4] *(Zonotrichia albicollis)*	✓	✓	✓	✓	✓	✓			✓	
White-crowned Sparrow[1,3] *(Zonotrichia leucophrys)*	✓						✓		✓	
Dark-eyed Junco[1,2,3,4] *(Junco hyemalis)*	✓	✓	✓	✓	✓	✓			✓	Woods road with cut bank, uprooted tree, etc. for nest site
Snow Bunting[1,3] *(Plectrophenax nivalis)*							✓		✓	

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Cardinalidae – Cardinals & Allies										
Northern Cardinal[1,3] *(Cardinalis cardinalis)*	✓	✓	✓		✓		✓	✓	✓	Thickets, vines
Rose-breasted Grosbeak[1,2,3,4] *(Pheucticus ludovicianus)*	✓	✓	✓	✓	✓					Forest-field ecotone, thickets, sapling stands of hardwoods
Indigo Bunting[1,2,3,4] *(Passerina cyanea)*	✓	✓	✓		✓					Forest-fields ecotones
Icteridae – Blackbirds, Orioles & Allies										
Bobolink[1,3] *(Dolichonyx oryzivorus)*							✓		✓	Wide expanses of grasslands
Red-winged Blackbird[1,3] *(Agelaius phoeniceus)*							✓	✓	✓	Grasslands, marshes
Eastern Meadowlark[1,3] *(Sturnella magna)*									✓	Grasslands, elevated perches
Rusty Blackbird[1,3] *(Euphagus carolinus)*						✓	✓	✓	✓	Northern woodland swamps, alder swales
Common Grackle[1,3] *(Quiscalus quiscula)*	✓	✓	✓		✓		✓	✓	✓	Wet, open country, shrub swamps, pond edges
Brown-headed Cowbird[1,3] *(Molothrus ater)*	✓	✓	✓	✓	✓	✓	✓		✓	
Orchard Oriole[3] *(Icterus spurius)*	✓									Open country with scattered deciduous trees
Northern Oriole[1,2,3] *(Icterus galbula)*	✓	✓	✓							Tall scattered deciduous (preferably elm) trees
Fringillidae – Fringilline Finches										
Pine Grosbeak[1,3] *(Pinicola enucleator)*	✓	✓	✓	✓	✓	✓				Northern conifer forest
Purple Finch[1,3,4] *(Carpodacus purpureus)*	✓	✓	✓	✓	✓	✓				Coniferous trees

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
House Finch[1,3,4] *(Carpodacus mexicanus)*	✓									Open ground with low seed-producing plants
Red Crossbill[1,3] *(Loxia curvirostra)*		✓			✓	✓				Northern coniferous forests
White-winged Crossbill[1,3] *(Loxia leucoptera)*		✓			✓	✓				Northern coniferous trees
Common Redpoll[1,3] *(Carduelis flammea)*	✓	✓		✓	✓	✓			✓	Open country
Hoary Redpoll[1,3] *(Carduelis hornemanni)*	✓	✓		✓	✓	✓			✓	Open country
Pine Siskin[1,3] *(Carduelis pinus)*	✓	✓		✓	✓	✓			✓	Conifers
American Goldfinch[1,2,3,4] *(Carduelis tristis)*	✓	✓	✓	✓	✓	✓	✓		✓	Open, weedy fields with scattered small trees
Evening Grosbeak[1,3] *(Coccothraustes vespertinus)*	✓	✓		✓	✓	✓			✓	Spruce and fir forest (breeding season)
Passeridae – Old World Sparrow										
House Sparrow[1,3] *(Passer domsticus)*									✓	

Sources:

1. DEM. 1979. Wachusett Mountain State Reservation Draft Management Plan.
2. Massachusetts Audubon Society Bird Census July 28, 1998
3. Degraff, R.M and D. Rudis. 1983 New England Wildlife: Habitat, Natural History, and Distribution. U.S. Forest Service.
2. VHB. 1998. Wachusett Mountain Ski Area Improvements, Final Environmental Impact Report, EOEA No. 9690. Prepared on behalf of Wachusett Mountain Associates.

Appendix F3: Amphibians and Reptiles Documented or Presumed to Occur within WMSR

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Amphibians										
Marbled Salamander[3] *(Ambystoma opacum)*	✓	✓	✓				✓	✓		Vernal Pool for breeding
Jefferson Salamander[3] *(Ambystoma jeffersonianum)*	✓	✓					✓	✓		Vernal Pool for breeding
Blue Spotted Salamander[3] *(Ambystoma laterale)*	✓	✓					✓	✓		Vernal Pool for breeding
Spotted Salamander[1,2,3,4] *(Ambystoma maculatum)*	✓	✓	✓	✓	✓	✓	✓	✓		Vernal Pool for breeding
Red-Spotted Newt[1,2,3] *(Notophthalmus v. viridescens)*		✓	✓	✓	✓	✓	✓	✓		Water w/ aquatic vegetation
Northern Dusky Salamander[1,3] *(Desmognathus f. fuscus)*		✓	✓	✓	✓	✓	✓	✓		Permanent woodland streams or seeps
Redback Salamander[1,3] *(Plethodon cinereus)*	✓	✓	✓	✓	✓	✓	✓			Logs, stumps, rocks etc.
Four-toed Salamander[3] *(Hemidactylium scutatum)*		✓	✓	✓		✓	✓	✓		Wet woodlands
Northern Spring Salamander[1,3] *(Gyrinophilus p. porphyriticus)*		✓	✓	✓		✓	✓	✓		Streams, seeps or springs
Northern Two-lined Salamander[1,3] *(Eurycea b. bislineata)*		✓	✓	✓	✓	✓	✓	✓		Streams for breeding
Eastern American Toad[1,3] *(Bufo a. americanus)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Northern Spring Peeper[1,2,3] *(Hyla c. crucifer)*		✓	✓	✓		✓	✓	✓		Pools for breeding

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Gray Treefrog[3] *(Hyla versicolor)*	✓	✓	✓				✓	✓		Seeps, aquatic sites for breeding
Bullfrog[1,3] *(Rana catesbeiana)*	✓	✓	✓				✓	✓		Deep permanent water with floating and emergent vegetation
Green Frog[1,2,3,4] *(Rana clamitans melanota)*							✓	✓		Riparian habitat
Wood Frog[1,3,4] *(Rana sylvatica)*	✓	✓	✓	✓	✓	✓	✓	✓		Vernal pools
Northern Leopard Frog[1,3] *(Rana pipiens)*							✓	✓		Wet meadows
Pickerel Frog[1,3] *(Rana palustris)*	✓	✓	✓	✓	✓	✓	✓	✓		Shallow, clear water of bogs or woodland streams
Reptiles										
Common Snapping Turtle[1,3] *(Chelydra s. serpentina)*	✓				✓		✓	✓	✓	Aquatic habitat, sandy soils or gravelly soil or banks
Wood Turtle[3] *(Clemmys insculpta)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	Wooded streambank
Eastern Box Turtle[3] *(Terrapene c. carolina)*	✓	✓	✓		✓		✓	✓	✓	Old fields, clearings with sandy soil
Eastern Painted Turtle[3] *(Chrysemys p. picta)*							✓	✓	✓	Ponds with projecting or floating logs
Northern Water Snake[1,3] *(Nerodia s. sipedon)*							✓	✓		Branches, logs overhanging water
Northern Brown Snake[3] *(Storeria d. dekayi)*	✓	✓	✓	✓	✓		✓		✓	
Northern Redbelly Snake[3] *(Storeria o. occipitomaculata)*	✓	✓	✓	✓	✓		✓		✓	
Eastern Garter Snake[1,2,3,4] *(Thamnophis s. sirtalis)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Eastern Ribbon Snake[3] *(Thamnophis s. sauritus)*		✓					✓	✓		Mesic woodlands with aquatic habitat

Species	Preferred Habitats									Special Habitat Needs[3] And Occurrence Notes
	Upland Forest Communities						Vegetated Wetland	Aquatic	Open Area	
	Early Successional Woodland	Birch Maple Forest	Oak Forest	Hemlock Forest	Pine Forest	Other Coniferous Forest				
Eastern Hognose Snake[3] *(Heterodon platyrhinos)*	✓		✓		✓		✓		✓	Sandy soils, open woodlands
Northern Ringneck Snake[3] *(Diadophis punctatus edwardsi)*	✓	✓	✓	✓		✓			✓	Mesic conditions with abundant cover
Northern Black Racer[3] *(Coluber c. constrictor)*	✓	✓	✓		✓		✓		✓	
Eastern Smooth Green Snake[1,3] *(Opheodrys v. vernalis)*	✓	✓	✓				✓		✓	Upland grassy opening
Eastern Milk Snake[1,3] *(Lampropeltis t. triangulum)*	✓	✓	✓		✓		✓	✓	✓	Slash, woodpiles, debris or loose soil for egg laying
Timber Rattlesnake[1,3] *(Crotalus horridus)*			✓							Rock ledges on forested hillsides

Sources:

1. DEM. 1979. Wachusett Mountain State Reservation Draft Management Plan.
2. VHB. 1998. Wachusett Mountain Ski Area Improvements, Final Environmental Impact Report, EOEA No. 9690. Prepared on behalf of Wachusett Mountain Associates.
3. Degraff, R.M and D. Rudis. 1983 New England Wildlife: Habitat, Natural History, and Distribution. U.S. Forest Service.
4. Epsilon Associates, Inc. 1998. Wachusett Mountain Summit Natural and Cultural Resources Inventory and Analysis. Report commissioned by DEM (NB: report incorporates faunal survey conducted by Oxbow Associates)

Appendix F4 : Invertebrates Documented or Presumed to Occur within WMSR

Species	Preferred Habitats							Special Habitat Needs[3]
	Hardwood Forest	Coniferous Forest	Forested Wetland	Shrub Swamp	Riverine	Lacustrine	Open Meadow	
Butterflies								
Black Swallowtail *(Papilio p. asterius)*								
Eastern Tiger Swallowtail *(Papilio polyxenes)*								
Cabbage White *(Pieris rapae)*								
Clouded Sulphur *(Colias philodice)*								
Orange Sulphur *(Colias eurytheme)*								
Banded Hairstreak *(Satyrium calanus falacer)*								
Striped Hairstreak *(Satyrium liparops)*								
Eastern Tailed Blue *(Everes comyntas)*								
Spring Azure *(Celastrina ladon)*								
Summer Azure *(Celastrina ladon)*								
Aphrodite Fritillary *(Speyeria aphrodite)*								
Great Spangled Fritillary *(Speyeria cybele)*								
Question Mark *(Polygonia interrogationis)*								
Mourning Cloak *(Nymphalis antiopa)*								
American Lady *(Vanessa virginiensis)*								
White Admiral *(Limenitis a. arthemis)*								

Species	Preferred Habitats							Special Habitat Needs[3]
	Hardwood Forest	Coniferous Forest	Forested Wetland	Shrub Swamp	Riverine	Lacustrine	Open Meadow	
Little Wood Satyr *(Megisto cymela)*								
Common Ringlet *(Coenonympha inornata)*								
Monarch *(Danaus plexippus)*								
Juvenal's Duskywing *(Erynnis juvenalis)*								
Least Skipper *(Ancyloxypha numitor)*								
European Skipper *(Thymelicus lineola)*								
Hobomok Skipper *(Poanes hobomok)*								
Odonates								

Sources:

1.

APPENDIX G

DEM Statewide Old Growth Policy

OLD GROWTH POLICY

Department of Environmental Management

Division of Forests and Parks

Bureau of Forestry

Old-growth forests are valued for their scientific, ecological and social significance. From a scientific perspective they serve as windows to the past. Increment cores of tree growth, microtopography and other features provide information that can be analyzed to ascertain past climatic events, forest fires and insect infestations that may have occurred hundreds of years ago (Henry and Swan, 1974). Old-growth forests provide opportunities to acquire baseline data that can help us understand how forest ecosystems develop over time without human influence. They are valued ecologically because they provide some habitat components that are not common in young forests. We are not aware of any organisms that are dependent on old-growth for their existence in Massachusetts, although a number of organisms preferentially inhabit older forests. Old-growth forests are revered for the social values associated with them. They provide a backdrop for some forms of outdoor recreation and some individuals take great comfort in knowing that there are some areas of forest land set aside in a wild and natural state and allowed to develop free from human influences.

The first formal inventory of old-growth forests in Massachusetts was carried out in 1993 by Dr. Peter Dunwiddie for the Massachusetts Natural Heritage Program. He analyzed 13 stands having a combined area of over 350 acres. These stands averaged approximately 25 acres in size and were located in Berkshire and Franklin Counties. Since that time, Dunwiddie and Robert Leverett have published an article, an update of Dunwiddie's earlier one, in Rhodora - The Journal of the New England Botanical Club, entitled *Survey of Old-Growth Forest in Massachusetts*. This survey documented an additional 15 stands in western Massachusetts and one in central Massachusetts. The total acreage reported in this most recent survey was 630 acres. These acreage figures are only approximate because these areas are located in rough, steep terrain and their often indistinct stand boundaries make precise delineation difficult. For the most part, these stands occur on lands administered by the Department of Environmental Management (DEM) although three of them are on private land. Until such time as a more authoritative source or more detailed information becomes available, such through the development of site-specific plans, the stands on DEM land documented in the two previously cited papers shall be considered to be the old-growth stands to which this policy will apply.

DEM's approach to the management of old-growth forests has been very low profile. Little effort has been made to publicize either the existence or location of these stands and that will continue to be the case. The only attempt to achieve public recognition of any of them took place in the early 1970s when a section of the Mohawk Trail and Savoy Mountain State Forests were dedicated as Society of American Foresters (SAF) Representative Natural Areas. This took place following the recognition brought upon the Cold River area by the investigative work by Robert Livingston and Paul Hosier of the University of Massachusetts Botany Department (Hosier, 1969). Shortly after that, the Hopper, on the west slopes of Mt. Greylock, which contained several old growth stands, was dedicated as an SAF Representative Natural Area and as a National Natural History Landmark. Recently, the "discovery" of an old-growth area on Mount Wachusett that, heretofore, did not meet the contemporary definitions of an old-growth forest has prompted a great deal of public interest in these areas.

In light of this interest, DEM has developed draft policies that were first presented at a public meeting at Mount Wachusett in July of 1997. Following that, written policies were circulated to the individuals and organizations that had previously expressed an interest in the management of old-growth forests for their comments. The policies were also published in the *Environmental Monitor*, to solicit public comments. A number of comments were received and the draft policies have been modified to accommodate them. The degree to which DEM can implement these policies and fulfill its other commitments will depend on a significant increase in its management resources.

These policies will be reviewed annually to determine if they reflect current scientific thought relating to old-growth forests. At the time of the review any new old-growth areas that have been noted will be considered for inclusion in the list of areas referenced by these policies.

A Definition of Old Growth:
Various definitions of old-growth forests have evolved over the last several decades and now include stands that previously were not considered to be old-growth. These definitions will, no doubt, continue to evolve and become more quantitative as more becomes known about these forests. A national effort has been underway since 1988 to develop and refine definitions of old-growth conditions in thirty-five eastern forest associations (White and Lloyd, 1994). This effort is being spearheaded by the U.S. Forest Service's Southern Region and is being carried out in cooperation with the Nature Conservancy. In addition to that, a number of scientists are working independently to study old-growth forests in the northeastern United States. Presently, the Department of Environmental Management subscribes to the criteria put forth by Cogbill (Cogbill, 1996) and Dunwiddie (Dunwiddie, 1993) as follows:

> **Minimum stand size**
> Stands greater than 5 to 10 acres are considered to be large enough to be self-sustaining in spite of natural disturbances and attrition. From a practical standpoint, stands of this size are also efficient to map and administer.
>
> **Lack of disturbance**
> There should be no evidence of significant, human post-European settlement disturbance - the most common forms of disturbance are either timber harvesting or agricultural use.
>
> **Age of older trees**
> Old -growth forests should have a component of old trees that are greater than 50% of the maximum longevity for that particular species. Little is known about this aspect of forest development. However, several sources of this information are available and will be consulted when appropriate (Fowells, 1965; Harrar, et. al. 1976; and Stahle, 1996).
>
> **Regeneration**
> Although old-growth stands are recognized primarily by the presence of old trees, to be self-perpetuating they must have a component of trees in younger age classes that can be recruited to fill voids in the canopy as overstory trees become senescent and die or as gaps are created by external influences.

In addition to the aforementioned features, old growth stands have other characteristics that are unique. Classic, textbook old-growth stands have a preponderance of large, tolerant, late-successional species such as hemlock, beech and sugar maple. Until recently, stands of this nature were the only ones that were considered as old-growth stands. The composition of stands sampled by Dunwiddie and Leverett (Dunwiddie and Leverett, 1996) ranged from pure hemlock through mixed hemlock-hardwood stands to pure hardwood stands. Early and mid-successional species such as white birch, white ash and black cherry, though not always lacking, do not occur in great numbers in these stands (Dunwiddie and Leverett, 1996). The old-growth stand on Mount Wachusett is the only one east of the Connecticut River in Massachusetts and is the only documented old-growth stand in Massachusetts that has a significant oak component (Cogbill. 1996; Foster, et. al. 1996).

Generally speaking, old-growth stands have greater amounts of coarse woody debris (cwd - dead limbs, stems and other woody material that is on the forest floor and is generally greater than 3" in diameter) than most younger stands. A recent study (Whitbeck, 1995) in the Cold River area of the Mohawk Trail State Forest showed the mean accumulation of cwd to be 30 tons per acre. The mean accumulation in nearby second-growth stands was 9 tons per acre. There was a great deal of variation, however, in both the old-growth and the young stands. Old-growth stands probably have more large, standing dead or structurally unsound live trees than younger stands. Previously disturbed middle-aged stands may have greater numbers of smaller and medium size snags than old-growth stands (McComb and Muller, 1983). However, the basal area of dead trees may remain constant through most developmental stages (Tritton and Siccama, 1990).

Gaps, or openings in the crown canopy, are another structural feature of old-growth stands. These gaps may range in size from a small gap created by the death of an individual tree to a large gap created by an extraordinary meteorological event. These gap-forming events are most often episodic, occurring infrequently after long intervening periods with little or no disturbance. A good example of a recent disturbance of this nature is the beech scale-nectria complex, consisting of a beech scale insect and a nectria fungus that was imported from Europe. It was first noted in the Canadian Maritime Provinces in the late 1800s (Shigo, 1972). The first recorded outbreak occurred 30 years later and the complex slowly spread southwesterly, reaching western Massachusetts in the 1960s. The complex created a tremendous amount of beech mortality (Twery and Patterson, 1984) and led to the establishment of gaps of various sizes, regeneration within them and a surge of coarse woody debris (Houston, 1975). This occurred in both second-growth and old-growth forests and its severity varied depending on stand composition.

Other examples of severe episodic events are the ice storms that the Northeast has experienced in 1921, 1942, 1958 and 1998. The effects of these ice storms are often restricted to a particular elevation with forests above and below the affected elevation remaining unaffected. Hurricanes are the most common, widespread meteorological disturbance in the New England region. The 1938 hurricane and many other lesser hurricanes have caused disturbances that have caused damage across entire landscapes. Tornadoes and microbursts are other gap-forming phenomena that are local in nature, but have significant impacts. It is unlikely that a "steady state" (where annual or periodic growth equals mortality) is ever really achieved in Massachusetts' forests except perhaps on a vast, regional landscape scale.

In Massachusetts, old growth forests are found where they have been protected either by severe topography from anthropogenic disturbance and severe weather and/or they occur on sites where the trees have little value for consumptive uses because the cost of their extraction exceeds their value for commodity uses.

Preserve and Maintain the Integrity of Existing Old-Growth Stands.

Areas that meet the criteria for old growth, as set forth in this policy, are excluded from any manipulative activities. Wildlife habitat improvement, road and trail construction, conversion to other land uses, silviculture and other activities that may have an adverse effect on old-growth forests will not be permitted. A natural disturbance such as a windstorm in an old-growth area will not be cause for its old-growth designation to be withdrawn. In most instances DEM will not implement remedial measures following natural disturbances that occur in old-growth areas. Exceptions to this may occur when intervention is required to reduce or forestall damage to the ecosystem as a whole or to ensure the public's safety. A severe insect or disease infestation, are two examples of situations that might lead to intervention, particularly from introduced pests, and human-caused wildfires. If remedial measures are undertaken it will only be with methods that create minimal disturbance. Guidelines for implementing this policy will be developed locally in the site-specific plans described below. Existing, low-impact uses such as hunting, fishing, pedestrian use on existing trails, etc. will continue to be allowed. The maintenance of existing roads and trails that pass through old-growth areas will be permitted, but will be restricted to the existing corridor.

Buffers adjacent to old-growth stands are necessary to minimize the influence of adverse edge effects and reduce the potential for the invasion of species that may have a deleterious effect on the old-growth ecosystem. In most cases, on DEM lands, old-growth areas are embedded in larger areas of protection forest that will remain unmanaged to serve as buffers and other resource protection functions. DEM will establish and maintain buffers adjacent to isolated old-growth stands that occur outside of protection forests. In so far as possible, these buffers will consist of forested areas where disturbance is either precluded or minimized. The location and extent of these buffers will be dealt with in the site-specific management plans that will be prepared for each stand or aggregation of stands.

Recently, growing interest in old-growth forests has led to the increased use of these areas by the general public and the scientific community. To minimize any deleterious effects that these activities might have, DEM has instituted a policy of requiring special use permits for formal group visits and for research activities that take place in these areas.

The special use permit:

Identifies responsible individuals.
Ensures that the activities are appropriate for the site.

Assigns liability.
Places time limits on the activities.
Requires that any research findings be shared with both DEM and the scientific community.

Utilize Existing Land Use Zoning to "Restore" Old Growth Characteristics.
As stated earlier, most old growth stands occur in areas where timber harvesting and changes in land use have not occurred because of their inaccessibility and/or steep terrain. On DEM land these areas are already classified as protection forests that preclude conventional forest management activities. It shall be DEM's policy to allow these areas to develop, without human intervention into stands that have characteristics of old growth stands. These areas will never meet the strict definition of old-growth forests since they have been disturbed previously. Nevertheless, over a long period of time they will develop most of the attributes of old-growth forests. In addition, these areas will serve as buffers around core old-growth stands.

In 1979, the Bureau of Forestry's *Forest Management Practices Generic Environmental Impact Report*, classified in excess of 12,300 acres that were withdrawn from conventional forest management. As one might imagine, most of this acreage occurred in Berkshire and Franklin counties. The best example of one of these areas is the upper Cold River Valley in the Mohawk Trail and Savoy Mountain State Forests. This area includes a broad range of topography, elevations, aspects, soil types, forest types and some of the most productive soils in the Commonwealth are found there.

Prepare Site-Specific Management Plans for Each Designated Old Growth Area.
These plans will deal with issues that can only be addressed locally in the context of their immediate environment. The issuance of special use permits, public access, boundary delineation, buffers, response to insects and disease, wildfire, etc. will be dealt with in these plans. Since the plans for stands that are in close proximity to each other can be dealt with collectively, only a minimal number of them will need to be developed. These plans will be a product of a team effort led by the Management Forestry Program staff and will include the property supervisor and staff from the Forest Health Program and the Bureau of Forest Fire Control.

Manage for Old Growth Attributes
Some attributes of old growth stands can be achieved through management of selected, previously disturbed stands (DeGraaf, 1989; Hunter, 1990). Some of these practices are:

Retain live "cull" and standing dead trees.
Many species of wildlife are dependent on cavities in both live and dead trees for their existence (Tubbs, et. al. 1986). Dead trees are also valuable as a substrate for feeding.

Retain coarse woody debris, either as standing trees or down material.
This will be accomplished either by felling certain trees and leaving them or by allowing some trees to remain unharvested and will eventually die (McMinn and Crossley, 1996; Gore and Patterson, 1986).

Leaving some unharvested trees.
This will be accomplished by leaving individual trees or aggregations of trees in otherwise managed stands. These trees could be left in perpetuity or through long rotations (see below). This practice would be used to create a more complex vertical structure and refugia for species that prefer older forests. One of the best opportunities for implementing this is the practice of creating unharvested or partially harvested riparian buffers (Murray and Stauffer, 1995)

Lengthen rotations.
Rather than utilize rotations (a rotation is the planned length of time it takes a stand or tree to achieve a particular level of maturity) that are often as short as 60 to 100 years, some even-aged stands will be allowed to develop for 120 to 150 or more years of age until they

are harvested . Trees in some unevenaged stands will be allowed to achieve larger maximum tree sizes than they ordinarily would (Hannah, 1994). There will be significant variation in exactly how this would be applied from site to site.

Practice single tree selection or group selection.
These practices are an appropriate management strategy for some forest associations and condition classes. (Smith, et. al., 1996). This will provide some structural attributes that are characteristic of old-growth stands that may be lacking in second-growth and even-aged stands.

The first three of these practices can and will be applied to some degree in all silvicultural operations on DEM land. Employing lengthened rotations and unevenaged management will require sophisticated site-specific analyses before their implementation.

It should be made quite clear that the foregoing management practices are intended to provide old-growth attributes in stands that are managed and should, in no way, be construed as measures for restoring old-growth forests.

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APPENDIX H

DEM General Land Stewardship Zoning Guidelines

DEM LAND STEWARDSHIP ZONING

GENERAL USE GUIDELINES

Environmental Protection Zone: Highly sensitive areas requiring a high degree of protection, such as rare species habitats or fragile archeological sites, are within this zone.

General guidance for activities within the Environmental Protection Zone include the following:

Recreation

- Only low impact activities permitted in this zone, including dispersed and non-motorized recreation.
- Intensive, development-dependent recreation not permitted.
- New trail construction permitted if limited to stable areas and located to avoid adverse impacts to rare species, and known or potential archaeological sites.

Visual Resources

- Retain area in natural state or preserve and enhance existing natural or cultural landscape.
- Minimal cutting to maintain or enhance vistas permitted.

Vegetation & Wildlife Habitat

- Intensive habitat manipulation not permitted except as recommended under the following guidelines.
- Natural Heritage & Endangered Species Program recommendations used to restore, maintain and enhance habitat of rare and endangered species, and rare exemplary communities.
- Research which causes no adverse impact to sensitive resources will be permitted through a formal written proposal process, approved in advance by the Director or his designee.
- Vegetation management allowed: Under habitat management plan utilizing native species to control erosion, stabilize dunes, enhance ecosystem diversity, and achieve other objectives consistent with protection of existing resources; or under historic landscape restoration plan.

- Limited cutting of vegetation allowed for maintenance of trails and existing roads.

Water Resources

- Sensitive wetland resource areas and associated buffers will be managed to protect and enhance habitat and water quality.

Silviculture

- No conventional timber sales allowed. Areas in environmental protection zone excluded from allowable harvest calculations.

Forest Protection

- Spread of major forest pathogens will be controlled with procedures compatible with existing sensitive resources.
- Research stations for monitoring forest health may be established.
- Wildfires will be extinguished by Bureau of Fire Control personnel coordinating with municipal fire departments.
- Fire breaks may be maintained in fire prone types of vegetation.

Transportation

- No new roads will be constructed.
- Passage through zone allowed on existing stable roadbeds or trails.

Facilities

- No new construction except for small scale, low impact facilities such as interpretive exhibits, handicapped ramps, viewing platforms and boardwalks.
- No new construction in historic or cultural resource areas unless part of a formal protection or restoration plan.

Conservation Zone**:** Areas in this zone are moderately sensitive, and may include those with managed woodlands, water resources, wildlife habitats, and agricultural resources. Opportunities for dispersed recreation are provided within this zone. General guidelines for this zone follow.

Recreation

- Opportunities for appropriate dispersed recreation will be provided.

Visual Resources

- Vistas will be opened in appropriate locations and open fields will be maintained.
- At least 50% shade will be maintained in a buffer strip along public access corridors.

Vegetation & Wildlife Habitat

- A high priority will be given to enhancing ecosystem diversity.
- Wildlife nesting and den habitat areas will be encouraged.
- Activities adjacent to wetlands will be undertaken with adherence to regulations developed under the Wetlands Protection Act in order to avoid adverse impacts.

Water Resources

- Emphasis will be on maintaining and enhancing surface and ground water quality.

Agriculture

- Suitable agricultural uses will be encouraged where appropriate.

Silviculture

- Forest lands are divided into productivity classes (high yield and standard) with only high yield sites managed intensively.
- Management systems will be utilized to secure adequate natural regeneration and age class diversity.
- Timber Stand Improvement operations will be used to improve the quality and vigor of inoperable stands.
- Upon completion of operation, skid roads and landings will be revegetated unless the roads are to be used as trails or for subsequent timber operations.

Forest Protection

- Spread of major forest pathogens will be controlled through environmentally sound programs.
- Research stations for monitoring forest health may be established.
- Wildfires will be extinguished by Bureau of Fire Control personnel coordinating with municipal fire departments.

- Fire breaks will be maintained in fire prone types of vegetation.
- Research plots for prescribed burning and other techniques of fuel management may be established in this zone.

Transportation

- New road construction permitted in stable areas.
- Skid roads and truck roads will be carefully laid out by the forester considering grades, drainage and stream integrity.

Facilities

- Small scale facilities are permitted such as gravel parking areas, picnic areas, boardwalks, 2-4 stall comfort stations, and viewing platforms.
- Visitor centers, bathhouses, maintenance facilities, playfields, intensive camping areas, and major developments are not appropriate in this zone.
- Utility corridors are permitted.
- Adaptive reuse of historic structures is permitted in conjunction with a historic restoration plan.
- New construction in a historic or cultural resource area must be recommended as part of a formal protection or restoration plan, or historic landscape restoration plan.

Intensive Use Zone: Areas which can accommodate high levels of visitor use and associated structures or maintenance facilities, as well as areas where resources can best tolerate intensive use(s).

Recreation

- Legitimate recreational activities recognized by DEM, including intensive development-dependent recreation, are permitted in appropriate locations.
- Hunting will generally be excluded for safety reasons. MGL Ch.90B prohibits the discharge of firearms within 500 feet of occupied structures.

Visual Resources

- New structures and landscape treatments will be designed to blend in with natural or cultural surroundings, including use of trees and shrubs to screen utility buildings from view.
- Existing vistas will be maintained, and additional vistas may be cleared.

Vegetation & Wildlife Habitat

- Vegetation in natural resource areas will be managed by clearing out exotic species wherever possible, and maintaining trees and shrubs when their presence does not adversely impact public safety or access.
- Emphasis will be on maintaining vegetation with value to nongame wildlife species.
- Small scale wildlife habitat improvements may be conducted.
- Landscape plantings will consist of native materials in natural resource areas and historically compatible species in cultural resource areas.

Water Resources

- Surface water resources may be used for recreation within constraints of maintaining public safety and water quality.
- Surface water and associated wetland vegetation will be managed following guidelines established in the Wetlands Protection Act.
- Ground water resources may be utilized for day use and camping facilities.

Silviculture

- Acreage in this zone is excluded from allowable harvest calculations.
- Treatments will be conducted to improve public safety related to hazard trees and fire suppression, and improve access for recreation and education programs.

Forest Protection

- Spread of major forest pathogens will be controlled through environmentally sound programs.

- Wildfires will be extinguished by Bureau of Fire Control personnel coordinating with municipal fire departments.
- Transportation
- All main roads and bridges will be constructed or maintained to support a 75,000 pound load.
- Use of roads by logging trucks may be restricted during periods of high visitor use.

Facilities

- Construction directly related to appropriate forms of recreation will be allowed, and will conform to state health, building and environmental codes.
- Administration buildings, maintenance areas, storage facilities, parking lots, operational structures, visitors centers, bathhouses, playfields, and intensive day use and camping areas will be located in this zone.
- Utility corridors will be permitted.
- Historic restoration, rehabilitation or reconstruction for interpretation or adaptive reuse of historic structures is permitted in conjunction with an historic restoration plan.

APPENDIX I

Approval Process for Wachusett Mountain Ski Area Maintenance Activities

CALENDAR

[note: Every month the Reservation Supervisor will meet with WMA to discuss on-going issues and to keep everyone informed]

January:
15 - minimum ($35K) Payment to Comm. of Mass. by WMA
last Wednesday - Adv. Council Mtg.

February:

March:
1st - Full Accounting of Land Acq. Trust fund to DEM
15th - WMA Summer Work Projects submitted to DEM
31st - WMA Off Season Events submitted to DEM

April
15 - DEM response to Off Season events
15 - Ski area closes
last wed. - Advisory Council Mtg.[joint Monitoring Bd. and Adv. Council review of Summer Work Projects]

May
15 - DEM response to Summer Work Projects

June
15 - WMA submits pricing schedule for upcoming season

July
15 - DEM response to pricing schedule
last wed. - Adv. Council. mtg.

August
** - mow ski trails/slopes (date to be determined)
** - review of Old Growth Forest indicators
** - walk ski trails and identify any "Hazard Trees"
** - Remove "Hazard Trees"
** - DEM Review of Management/Resource Protection Plan to identify "to-do's" in Reservation
** - Review Land Acquisition List(s)

September
15 - WMA submits to DEM upcoming (ski) season Brochure [See Lease Sect E: Schedule of Operation)
** - Meet w/ WMA for Annual Review of Lease (Insurance's, safety, payments, etc.)
** - Annual Review of WMA/Fitchburg Water Agreement

October
10 - DEM approval due to WMA's 9/15 submission (Lease)
last wed. Adv. Council. Mtg: "State of the Mtn. Report"

November
1 - Roads to Summit Closed
** - DEM Interpretor provides annual "Environmental Awareness" session with Ski Area Mgmt. Team.
day after Thanksgiving (weather-permitting): Ski Area Opens

December
15 - WMA payment (balance of last year) due to DEM
15 - Full Payment to Land Acq. Trust Fund by WMA

Revised 4/28/99 c:calendar.doc

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

100 CAMBRIDGE ST., BOSTON, MA 02202 617-727-3180 FAX 727-9402

Argeo Paul Cellucci
GOVERNOR

Trudy Coxe
SECRETARY

Peter C. Webber
COMMISSIONER

SPECIAL USE PERMIT
FOR
WACHUSETT MOUNTAIN ASSOCIATES
WACHUSETT MOUNTAIN STATE RESERVATION

Pursuant to the authority set forth in Chapter 21, Section 4A and Chapter 132A, Sections 2B, 2D and 7 of the General Laws of the Commonwealth of Massachusetts; rules and regulations promulgated thereunder (including 304 CMR 12.00 et seq.), and all other power enabling:

The Commonwealth of Massachusetts, Department of Environmental Management, 100 Cambridge Street, Boston, Massachusetts (hereinafter "the Department"), does hereby authorize WACHUSETT MOUNTAIN ASSOCIATES, JEFF CROWLEY, PRESIDENT (hereinafter the "Permittee") to UTILIZE THE LAND AREAS (no more than 20 acres, and referenced below) DIRECTLY ASSOCIATED WITH THE OPERATION OF THE LEASED SKI AREA ON WACHUSETT MTN. STATE RESERVATION.

In order to protect the rights and safety of the general public as well as to insure the reasonable exercise of the permitted use, the following conditions and provision shall govern:

1. The Term for the use authorized hereby shall be for a period of five (5) years beginning 7/1/98 and terminating 6/30/2003. Renewal of this permit shall be the responsibility of the Permittee to request. Requests must be in writing and submitted to the Department (at 100 Cambridge St., Boston, Ma. 02202 attention: Director of Forests and Parks) no later than 60 days prior to the date of termination. Failure to request renewal within the prescribed time will result in automatic termination of this permit and revocation of all rights authorized herein.

2. The land area associated with this Permit is:
(1)all non-forested/open area(s) at the Summit Lift including the land area beneath the existing lift terminal (+/- 5 acres);
(2) the upper sections of Conifer Connection and Balance Rock Trail, Ropers Road Trail and the "Down" Road (all within the 1600' elevation and up-gradient to the 2000' elevation). (+/- 15 acres);
(3)any lands presently used for skiing and/or ski area operations up-gradient from the 1000 foot elevation to the 1300 foot elevation along Mountain Road (+/- 2 acres); and
(4)any pavement within the lands from the 1000 foot elevation to the inter-section of the Ski area entrance and Bolton Road (+/- 1 acre).

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3. The Permittee agrees to conform to all laws, rules and regulations of the Division of Forests and Parks and those of all other state, federal and local agencies. Permittee shall file for and obtain all necessary federal, state, and local permits.

4. This permit is not transferable and no privilege contained herein may be assigned or sublet to any other person or organization.

5. Permittee's use of the site is not exclusive. Members of the general public may use the site for the purposes authorized herein and shall be subject to the rules and regulations of the Department and of the Permittee.

6. The exercise of this permitted use shall constitute Permittee's acceptance of complete liability and responsibility for Permittee's use of the property and its actions and the actions of its members, guest, invitees, agents and employees upon the site, and an agreement that the Permittee will indemnify and hold harmless the Department against any and all claims that may arise therefrom. Further, the Permittee will not make any claims against the Department for any injury, loss or damage to persons (including bodily injury or death) or property occurring from any cause arising out of the authorized use by the Permittee, its agents or guests.

7. The Commissioner of the Department or the Director of the Division of Forests and Parks may cancel this permit at any time and for any reason which, in his sole opinion and judgment, is in the best interest of the Department.

I have read the foregoing conditions and provisions and approve of and agree to these terms.

1/26/99
Date Issued

Todd A. Frederick, Director
Division of Forests and Parks

10.27.98
Date Accepted

Jeff Crowley, President
Wachusett Mountain Associates

1/26/99
Date Approved

Peter C. Webber, Commissioner
Dept. of Environmental Management

Date Received, by DEM ______________________

OFF-SEASON EVENT FORM - WACHUSETT MTN. SKI AREA

[Note: This form relates to "Guidelines for the Mgmt. of Off-Season Public Events at Wachusett Mountain Ski Area", and is to be submitted to the Reservation Supervisor (See "Calendar", separate form).]

[AN "EVENT LAY-OUT" (see "1") MUST ACCOMPANY THIS FORM]

EVENT NAME: ______________________ DATE(s): ______________

CATEGORY (See "2"): ______________ HOURS: ______________

EST. # PEOPLE: ______ Parking lot(s) to be used: __________

TRAFFIC CONTROLS (See "3"): ______________________________

____

WILL EVENT UTILIZE AREAS OF THE RESERVATION OTHER THAN THE SKI LODGE AND BASE AREA? ____ IF YES, WHERE: ______________

____

WILL SKY RIDE BE OPERATING? _____ (yes/no).

IF THE EVENT WILL USE AREAS OUTSIDE THE BASE LODGE, THEN WHAT ENVIRONMENTAL SAFEGUARDS WILL BE NEEDED/PROVIDED?

____

____

____

HAS THIS EVENT BEEN HELD PREVIOUSLY AT WACHUSETT? _____ (y/n).

IF SO, WHEN? ____

IS THERE A CHARITABLE COMPONENT TO THIS EVENT? ____________

______________ IF YES, WHAT? ______________________________

____

OTHER: ____

key:

"1": A map showing locations of stages, tents, vendors, loud speakers, etc.

"2": Examples are: Festival; Musical; Road Race; Car Show; etc.

"3": Example: will police traffic detail be needed; additional parking staff; etc.

______________________________ ______________________

Reservation Supervisor Date Approved

Comments: ____

____

REVISED 5/21/99 [c:\evntform.doc]

GUIDELINES FOR THE MANAGEMENT OF OFF-SEASON PUBLIC EVENTS AT WACHUSETT MTN. SKI AREA

/8

FROM SECT. "X" of the existing Lease between Wachusett Mtn. Associates (WMA) and the Dept. of Environmental Management (DEM): " The ski lodge, accessory buildings and developed base area may at all times be used by the Lessee for public and private recreational purposes compatible with the site and consistent with the right of the public at all times to experience at the mountain the quiet enjoyment of nature."
[DEM recognizes the Base Lodge as a Four-Season Facility, and shall not unreasonably withhold approval for "off-season" events.]

PUBLIC EVENTS (also See "Event Form" c:\evntform.doc):
1) WMA submits to DEM by March 31 of each year the list of proposed summer/off-season events planned for the Ski Base Lodge area.
(a) Each event should have an "event form" completed and submitted with the list.
2) DEM will respond in writing by April 15 of each year to the submitted list, and "event form".[section removed]
4) Any events requested to WMA after the 3/31 date will have an "event form" submitted. DEM will respond within 7 days.

PRIVATE EVENTS:

In the spirit of the partnership recognized by WMA and DEM through the above referenced Lease, WMA will give prior notice to the Reservation Supervisor, and submit a completed "event form", as soon as WMA has accepted/approved an event which will utilize the outside base lodge area (deck & lodge) by more than 250 people, and/or intends to use the areas on or around the snowmaking pond.

This will allow DEM staff to be knowledgeable of all events on-going in the Reservation.

GENERAL CONDITIONS:

WMA will:
* comply with all federal, state, local regulations and obtain necessary permits; including assurances that Noise levels produced will not surpass existing Dept. of Env. Protection approved levels;
* assure that attendance levels will be based-on present parking capacity of WMA parking lots;
* provide signing at the Sky Ride Summit, informing the public that no foot traffic is permitted on ski trails during the off-season and to use existing hiking trails;
* obtain DEM approval;

[Note: Review of this "Guideline" can/should be a discussion topic at the regularly scheduled mtgs. between WMA and Reservation Supervisor.]
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WACHUSETT MOUNTAIN STATE RESERVATION SUPERVISOR'S LETTER TO ALL PERMITTEES

DEAR PERMITTEE: THIS FORM LETTER IS AN **ALERT** TO MAKE SURE YOU ARE FULLY AWARE OF THE SENSITIVE ENVIRONMENT AT WACHUSETT MOUNTAIN STATE RESERVATION.

YOU ARE BEING SENT THIS SINCE YOU ARE THE HOLDER OF AN APPROVED SPECIAL USE PERMIT AT WACHUSETT. THIS LETTER DOES NOT CHANGE ANY OF THE TERMS OR CONDITIONS OF THAT PERMIT, HOWEVER, IF YOU DO NOT RECEIVE THE PERMISSION OF THE RESERVATION SUPERVISOR (SEE BELOW), PRIOR TO DOING WORK - YOUR PERMIT MAY BE SUSPENDED OR CANCELED.

NO WORK IS ALLOWED WITHOUT PRIOR REVIEW AND PERMISSION FROM THE RESERVATION SUPERVISOR.

PLEASE CONTACT MY OFFICE [(978) 464-2987] PRIOR TO GOING INTO THE RESERVATION SO THAT WE CAN DISCUSS YOUR PROPOSAL,

SINCERELY,

DATE

RESERVATION SUPERVISOR

C:\PERMITEE.DOC

February 14, 1997

Approval Process for All Construction, Maintenance and/or Alterations at Wachusett Mountain Ski Area

A. On or before March 15th of each year, Wachusett Mountain Associates (WMA) shall submit to the Department of Environmental Management (DEM), working plans and specifications and proposed project schedules for all work projects proposed to commence within the following 12 months. Work projects shall include but not be limited to the erection, modification, addition, removal or alternation of any building(s), lift(s), natural features or resources, or structures of any nature and/or projects involving removing, filling, dredging, drilling, excavating, grading or landscaping within the leased premises. Work projects which fall within the Old Growth areas, as identified in the Cogbill or Harvard forest Reports, and/or are or may be subject to the Wetlands Protection Act, or any other local, state or federal statutes and/or regulations, shall be so identified and complied with accordingly.

B. WMA shall submit three (3) copies of all plans and specifications and proposed project schedules to the Director of Forests and Parks and three (3) copies to DEM's Regional Director in Clinton. Plans and specifications shall be of sufficient detail to describe the project, specify locations and materials, and illustrate all proposed alterations to the natural environment.

C. Following DEM's review of the plans and specifications, all members of the Wachusett Mountain Advisory Council (WMAC) and the Wachusett Monitoring Board (MB) shall be provided copies of plans and specifications for review. Plans shall be provided at least one week prior to the meeting discussed below. On or before April 15th of each year, DEM shall convene a joint meeting of the WMAC and MB, at which time WMA work projects shall be presented and discussed. Written notification of this meeting shall be sent to the Towns of Westminster and Princeton Boards of Selectmen and Conservation Commissions. DEM shall consider the recommendations of the MB and the WMAC in making decisions regarding approval or disapproval of the proposed work projects.

D. DEM shall make every reasonable effort to respond to WMA's project requests by May 15th, provided that all required permits or approvals by applicable local, state or federal agencies have been applied for and received or likely will be received prior to project commencement.

E. No work projects submitted to DEM by WMA after March 15th shall be considered for approval, excepting unforseen emergency projects which pose or are likely to pose an immediate threat to the health, safety, or well being of humans or the environment or pose a serious financial impact for WMA.

F. "Routine Maintenance' shall be defined as work projects which do not involve filling, grading, drilling, excavating, dredging or landscaping or the erection, modification, addition, removal or alternation of any building(s), lift(s), natural features or resources, or structures of any nature. Examples or routine maintenance include annual trail and pond maintenance as outlined in an agreement between DEM and WMA, dated October 30, 1985, interior painting of buildings and small scale reseeding projects and work included in the Princeton and Westminster Conservation Commissions' " Order of conditions" for maintenance work in wetland areas.

G. "Emergencies" shall be defined as any events which pose an immediate threat to the health, safety or well being of human or the environment, such as broken water or air lines significant erosion problems, etc., or pose a serious financial impact for WMA. In such cases, WMA shall take immediate steps to stabilize the situation and shall notify DEM as soon as possible. DEM shall immediately review the situation and determine a proper future course of action. DEM shall make all reasonable efforts to contact the chairmen of the MB and the WMAC and the City of Fitchburg's Water Quality Manager's office and apprise them of the situation.

H. Any and all activities or work in the Old Growth area, as the area is defined in the Cogbill and Harvard Forest Reports, shall be given special consideration and be subject to review and approval by DEM on a project to project basis, after consultation with the WMAC and the MB.

I. All work projects involving drilling, excavating, grading or landscaping shall be completed by the end of August. All reseeding, mulching or other forms of stabilization shall be performed within 10 days of project completion and in no event later than September 15th.

J. No deviation from this process shall be permitted without the prior approval of the Director of Forests and Parks.

LAND ACQUISITION FUND TRUST AGREEMENT

WACHUSETT MOUNTAIN ASSOCIATES, A LIMITED PARTNERSHIP ("WMALP") whose general partners are JOSEPH H. O'BRIEN, JR. of Princeton, Massachusetts, and WACHUSETT MOUNTAIN ASSOCIATES, INC. ("WMA"), a Massachusetts corporation with its principal place of business in Princeton, Massachusetts, hereby agrees to pay to SUMNER B. TILTON, JR. of Worcester, Massachusetts, as Trustee of this LAND ACQUISITION FUND (the "Trustee") the sums as hereinafter described, said sums and the net income derived from the same to be held by the Trustee in trust for the benefit of the COMMONWEALTH OF MASSACHUSETTS acting through its DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (the "Department") upon the terms as set forth herein.

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FIRST: It is the intention of WMALP and the Department to create a fund for the acquisition of land as is provided for in Section J (2) of a certain lease dated December 15, 1982, by and between the Department as Lessor and WMA as Lessee and assigned to Wachusett Mountain Ski Area Inc. and then to WMALP by two assignments dated November 29, 1982 (the "Lease"). This trust fund is created for the purpose of acquiring additional lands deemed available and desirable for conservation and recreational purposes by the Department. Said land shall primarily be acquired abutting or in the vicinity of the Wachusett Mountain Reservation but may, at the discretion of the Department, be

Return To: Donald J. O'Neil
Mountain Dearborn & Whiting
370 Main Street
Worcester, MA

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acquired at any locale in the Commonwealth. Distributions from the trust fund shall be limited to the acquisition of lands as described above.

SECOND: The trust shall be funded by annual contributions by WMALP to the Trustee. The amount of the annual contribution shall be computed in accordance with the formula set forth in Section J (2) of the Lease as the same shall be amended from time to time.

THIRD: The Trustee shall keep the trust fund (including all net income earned thereon) invested in an interest bearing account in a bank or other savings institution licensed in the Commonwealth. Except as provided in Section Eighth, distributions from the trust fund shall be made by the trustee only upon written direction of the Department and shall be utilized solely for the purchase of lands or interests therein as above provided for, such lands or interests therein to be purchased in the name of the trust and then gifted over by deed subject to the provisions of Chapter 132A of the General Laws to the Commonwealth. Such direction to purchase land or interests therein shall require the signatures of both the chief executive officer of WMALP and the Director of the Division of Forests and Parks or their successors or designees. Direction to purchase land shall be at the discretion of the Department and WMALP shall be required upon receipt of notice from the Department to execute all necessary instruments to compel the Trustee to purchase such land or interests. All costs incurred by the Trustee in the purchase and gifting of land under this paragraph shall be paid by the Trustee from the trust fund. Such costs shall include, but not be limited to legal fees incurred for drafting or reviewing agreements and deeds, title search costs and recording fees.

FOURTH: The Trustee may resign at any time by notifying WMALP and the Department by certified mail of his resignation. The Department shall have the right to remove the Trustee at any time by notifying the Trustee by certified mail of his removal. The resignation or removal shall be effective upon receipt of such notice. In the event the Trustee is removed, resigns, dies, or is otherwise unable to serve, then a successor Trustee shall be appointed by the Department. Upon appointment, any successor Trustee shall be the Trustee as if originally named and shall hold title to the trust fund without the necessity for any transfer to him by the previous Trustee.

FIFTH: No Trustee shall be required to give bond or furnish surety on any bond required by law.

SIXTH: The Trustee shall be entitled for his services to reasonable compensation and to reimbursement for his expenses. Payment of such compensation and reimbursement shall be made from the trust fund.

SEVENTH: This trust shall expire upon the expiration of the Lease. Upon such expiration, all monies remaining in the trust funds shall be paid to the Commonwealth for the purposes as described in Section First.

EIGHTH: The Trustee and the Department shall agree, in writing, as to the amount the Trustee shall be paid each year as compensation for his services as Trustee. Initial compensation shall be established at $150.00 per year and shall constitute payment in full for preparation of an annual account, preparation of federal and Massachusetts income taxes and payment of the same, distribution of funds and the continuing investment of the trust fund. The Trustee shall be authorized to pay such compensation and any taxes due any federal, state, county or municipal entity from the trust fund upon his own authority and may make any withdrawals necessary to pay such compensation or taxes without prior authorization from WMALP or the Department.

NINTH: The Trustee shall not be liable to WMALP or the Department or to any other entity or person for any act or omission by the Trustee in the good faith performance of his duties as Trustee. WMALP and the Department agree to defend, indemnify and hold the Trustee harmless for any such alleged liability.

TENTH: Within sixty (60) days following the close of each calendar year the Trustee shall render to the Department an accounting for the previous calendar year. If the Department approves such account in writing or, having received any such account and having made no objection in writing within ninety (90) days of the receipt of such account, such written approval or absence of objection shall be conclusive evidence that the transactions evidenced by such account were in accordance with the terms of this agreement.

Executed in triplicate this 20th day of April, 1984.

WACHUSETT MOUNTAIN ASSOCIATES, A
LIMITED PARTNERSHIP

Wachusett Mountain Associates, Inc.
General Partner

By ______________________
President

Joseph H. O'Brien, Jr.
General Partner

COMMONWEALTH OF MASSACHUSETTS
through its Department of Environmental Management

By Gilbert A. Bliss

COMMONWEALTH OF MASSACHUSETTS

WORCESTER, SS. April 20, 1984

Then personally appeared the above named Joseph H. O'Brien, Jr. and acknowledged the foregoing instrument to be his free act and deed, before me,

Henry W. Beth

Notary Public: Henry W. Beth
My Commission Expires: 1/30/87

I, HENRY W. BETH, Trustee of the Land Acquisition Fund, hereby certify that this is a true and accurate copy of the Land Acquisition Fund Trust Agreement.

Henry W. Beth

Henry W. Beth, Trustee
Land Acquisition Fund

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss. June 27, 1996

Then personally appeared the above-named Henry W. Beth and acknowledged the foregoing instrument to be his free act and deed, before me,

Donald J. O'Neil, Notary Public
My Commission Expires: 09/11/98

ATTEST: NO. WORC REGISTRY OF DEEDS
JOHN B. Mc.LAUGHLIN, REGISTER

FIRST AMENDMENT

TO

LAND ACQUISITION FUND TRUST AGREEMENT

Reference is made to a Land Acquisition Trust Fund Agreement dated April 20, 1984 among Wachusett Mountain Associates, a Limited Partnership ("Wachusett"), Sumner B. Tilton, Jr. now succeeded by Henry W. Beth, Trustee (the "Trustee") and the Commonwealth of Massachusetts acting through its Department of Environmental Management (the "Department"). Wachusett, the Trustee and the Department hereby amend the said Land Acquisition Trust Fund Agreement as follows:

Article THIRD is amended by deleting the first sentence and substituting the following language for it:

> "The Trustee shall invest the Trust Fund in qualified Investments as hereafter defined.
>
> "Qualified Investments" means (i) any bonds or obligations which as to principal and interest constitute direct obligations of or are guaranteed by the United States of America, (ii) investment agreements with a bank, trust company, national banking association, insurance company, financial services company or other similar organization which is, rated in, or the parent of which (if the parent has fully guaranteed its subsidiary's obligations) is, at the time the agreement is entered into, rated "A" (without regard to gradations by Moody's or S&P or their successors, (iii) commercial paper or finance company paper which is rated not less than prime-one or A-1 or their equivalents by Moody's or S&P or their successors, (iv) bonds, obligations or commercial paper of the District of Columbia, any territory of the United States of America or any state of the United States of America or any political subdivision or other instrumentality of the foregoing, the interest on which is excluded from gross income for federal income tax purposes, which have maturities of 91 days or less and which are rated in one of the two highest categories for such securities by Moody's or S&P or their successors, (v) shares of any so-called "money market fund" that has at least 85% of its assets invested in investments of the types described in clauses (i), (ii) and (iii) above, (vi) shares of any open-end diversified investment company which is a "regulated investment company" within the meaning of Section 851(a) of the Internal Revenue Code of 1986, as amended (the "Code") and which, for the taxable year, meets the requirements of Section 852(a)of the Code, which maintains a constant net asset value per share in accordance with regulations of the Securities and Exchange Commission, has authorized

and outstanding only one class of stock, has aggregate net assets of not less than $50 million on the date of purchase, and either derives at least 85% of its gross income from interest on or gains from the sale of investments described in clause (iv) above or has at least 85% of the weighted average value of its assets invested in investments of such types, provided that the purchase of any shares in any particular investment company shall be limited to an aggregate amount owned at any time of $1,000,000; (vii) repurchase agreements ("Repurchase Agreements"), the maturity of which are less than thirty (30) days, entered into with a bank or trust company organized under the laws of any state of the United States or with a national banking association, insurance company, or government bond dealer reporting to, trading with, and recognized as a primary dealer by the Federal Reserve Bank of New York and which is a member of the Security Investors Protection Corporation which has a short-term rating in the highest rating category (without regard to gradations) by Moody's or S&P, (viii) an interest-bearing savings account in banks or trust companies organized under the laws of the United States of America or any state thereof, the interest on which is payable at least as often as quarterly and withdrawal from which is unrestricted as to prior notice; (ix) any so-called "money market fund" mutually satisfactory to Wachusett, the Trustee and the DEM; and (x) any demand deposit or similar account with banks or trust companies."

Signed as a sealed instrument this 21st day of September, 1998.

Wachusett Mountain Associates,
a Limited Partnership

By: Wachusett Mountain Associates, Inc.
its sole general partner

By:
Name: James [illegible] Crowley
Title: President

Henry W. Beth, Trustee
Henry W. Beth, Trustee

Commonwealth of Massachusetts
through its Department of
Environmental Management

By:
Name: Peter C. Webber
Title: Commissioner

ACME
BOOKBINDING CO., INC.

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100 CAMBRIDGE STREET
CHARLESTOWN, MASS.